ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVII. No. 7. NEW YORK, SATURDAY, AUGUST 12, 1905. ISSUED WEEKLY

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TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single Copies, each 10

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PERFORMANCE OF A GAS-DRIVEN ELECTRIC STATION.

The gas engine for driving electrical machinery in large stations is still on probation and statistics relating to the performance of such stations are interesting even though the conditions be peculiar. An instance of this kind is that of an electric light and power station at Ryde on the Isle of Wight, England. This station is equipped with 200 kilowatts in generators. It supplies power to 346 consumers. For the last calendar year the total amount of power sold from this station was only 78,505 kilowatt-hours. The maximum demand on this station was only eighty-five kilowatts. The load-factor on the assumption that the maximum demand had been constant is only 10.5 per cent. Figured on the station equipment, it is less than 4.5 per cent. With such a low load-factor the cost of operating the station was necessarily high, and in addition there were some exceptional charges for rents which add considerably to this. The cost at switchboard is given as 5.64 cents. The cost per kilowatt-hour for distribution is something over six cents. The total cost per kilowatt-hour, allowing for management charges, is a little over ten cents. These figures are significant only as showing what may be expected under poor conditions. It is probable that a steam plant would have done no better, perhaps not as well.

ELECTRIC RAILWAY DEVELOPMENT.

An exceedingly interesting discussion of the marvelous growth of the electric railway since its first success in Richmond, Va., is given in the *Century Magazine* for July and August, by Mr. Frank J. Sprague, to whom is due the credit for the success of this road. Great as was Mr. Sprague's achievement in adapting an electrical system to a street car, his later system, brought out about ten years after his first success, is almost equally important. For, while the first road pointed the way to a satisfactory transit system for city streets, the second has banished locomotives from elevated structures and made possible by means of elevated roads and subways a solution of the transportation problems confronting all large cities. The multiple-unit system has not only driven the locomotive from the transit systems of our cities, but it has given to those large steam roads which, due to local conditions, have found it necessary to electrify certain sections of the road, a method to handle efficiently trains of any type and weight.

As to the future, Mr. Sprague is not in doubt. While changes may take place, and, indeed, should take place in every healthy industry, he does not believe that the steam locomotive will soon be superseded by the electric. There is no question as to the physical possibility of doing any work now done by the steam locomotive as well or even better than it is done now. The all-important question is, will such operation prove profitable? Electric systems are unavoidably expensive, and when substituted for steam they must pay for the discarded apparatus. The electric roads have a large field as supplementary to the trunk lines, and it is probable that greatest growth will be in developing this field.

While on the subject of electric railway developments, it is interesting to note that a practical trial is to be made of a direct-current regenerative system in the city of Birmingham, England. Forty-one cars, equipped with the Raworth regenerative control system, are being put in service in order to give this system a thorough test. In America regenerative systems have not appealed particularly to the engineer, but the possibility of returning some forty or fifty per cent of the energy delivered to a car to the line is worthy of investigation, though perhaps it may be well for some one else to bear the expense of the experiment.

NIAGARA POWER FOR ELECTRIC HEATING.

Electric plants now under construction at Niagara Falls are designed for a combined output of 500,000 horse-power. As the plants already in operation at the falls are not yet fully loaded, though one of them furnishes energy for the electric supply and railway systems in Buffalo, the possible loads for the new plants is a subject of some speculation. While the existing Niagara plants have displaced a very large capacity in steam engines, both at the falls and in Buffalo, and are supplying large volumes of energy for electrochemical and industrial furnaces, they do no more than a trifling amount of general heating in business blocks and residences. It is therefore of interest to enquire what proportion of the 500,000 prospective electric horse-power that is to come onto the market can probably be utilized for general heating of buildings in the city of Niagara Falls or Buffalo, which latter is only twenty miles away.

From the heat equivalent of 2,565 Fahrenheit units per electric horse-power-hour, it appears that plants of 500,000 horse-power capacity will deliver energy that represents 1,282,500,000 such units during each hour that they are operated at full load. To avoid the use of such large numbers the amount of heat just mentioned may be reduced to its equivalent in the capacity of tons of coal at 2,000 pounds each. For this purpose the useful warming effect of one pound of coal may be taken at 6,000 heat units when burned in stoves and furnaces. The quantity of heat just named represents only about one-half of the stored energy of the fuel, but it is all that is usually secured for warming purposes. On this basis each ton of coal yields 12,000,000 heat units for warming, and the electric output of the plants with 500,000 horse-power capacity during one hour at full load would displace 107 tons of coal nearly. If these plants should be kept in continuous operation at their rated capacity during the 8,760 hours of a year, their output for warming purposes would take the place of 937,320 tons of coal. No doubt it would be impracticable to keep the equipments constantly working at full capacity, but the figures may be used to show the maximum possible output.

During the year 1903, the imports of coal at Buffalo amounted to 6,338,256 net tons of anthracite, and 3,153,141 net tons of bituminous. From these quantities the exports took away 48,518 tons of bituminous and 3,261,544 tons of anthracite by lake and canal, and 4,230,256 tons of both varieties by rail. This left 951,069 tons for consumption in the city, or a little more than the equivalent of the electric output above named in heating capacity. Unfortunately it is not possible to determine how much of the coal consumed in Buffalo was anthracite, or what part of it was used for power purposes. As the coal burned under power boilers must have been a fairly large percentage of the total, and as coal used for power would be displaced by electric energy at a much greater rate than would coal for heating, it seems that the 500,000 horse-power plants at Niagara Falls, if worked continuously at full capacity, would be more than sufficient to supply all the heat, light and power required in Buffalo. This is on the assumption that the energy would be wanted constantly as generated, but such is not the case either as to the hours of each day or the several months of a year. It would probably result that in the colder months the full 500,000 horse-power of output would be required in Buffalo alone during a large part of each day, and that in the warmer months this output would be much greater than that city could utilize. But within one hundred miles of Niagara Falls are Toronto, Hamilton, Rochester and Erie, as well as Buffalo, and it seems probable that the requirements for light, heat and power in all of these places would tax the capacity of plants rated at 500,000 horse-power, even in summer.

Whether the rates that could be got for the energy devoted to heating would be sufficient to show a fair return on the investments in these plants is an intricate question, but it seems certain that there is enough heating to be done to load these new plants during the greater parts of most days in the year.

ELECTRICAL MEANS FOR AUTOMATIC CONTROL.

A feature of electrical apparatus which was early recognized was the opportunity for automatic control or regulation. This feature has been consistently developed and extended during the wonderful progress of electrical engineering until to-day it is doubtful if there is any other class of apparatus comparable to it in this respect. The extension has been made not only to nearly all pieces of apparatus, but to aggregation of many units, each of which performs a definite duty, but is so correlated to the others as to make the group a perfect whole, self-contained and almost self-operating. In fact, were it not for those unpreventable happenings, which no one can foresee or provide for—a sudden storm, a stoppage of the oil supply—there would be little need for apparatus in electrical stations. As it is, the duty of the operator to-day is not so much to regulate the working of a station as to prevent outside influences from interfering and to be at hand in case of accidents.

Automatic control at first was, as might be expected, accomplished by separate devices. That is to say, they were distinct appliances adapted to control the performance of another mechanism. But later, when the behavior of electrical machinery had been more thoroughly studied, and the various reactions taking place were recognized and understood, it was found that certain of these reactions could be utilized in many cases to bring about the control which had previously been accomplished by a separate device. This method, when possible, may be considered superior to the earlier method, as it accomplishes the end with one mechanism and in general the control is quicker, a vital feature of many electrical machines. In many instances, however, the older method has advantages which have caused it to be retained. If, for example, the point of control is to be at some distance from the machine controlled the controller must be a separate device.

The automatic control has been extended marvelously of late and has brought increased safety to the system and comfort to the user. In the newer electric railway equipments the man in control merely determines when the train shall start. He has

no control over the rate at which the train is put in motion. The same condition obtains in the newer electric elevator systems where every contingency is provided for. How far it will be advisable to extend the principle the future alone will determine, but there seems to be no reason why we should stop where we are.

Certain features of electrical methods of automatic control have brought about their adoption in non-electrical industries. They have, indeed, led to important improvements, or even new developments, which would not have been practicable by any other means. Principal among these features are the independence of the controlling device of the location of the device controlled, and the ability to direct a relatively large amount of power by means of a small delicate device. A little instrument sensitive to temperature may be made to regulate a large supply of heat coming from a distance. It is no more difficult to regulate the supply of water to a tank when the pump is a mile or more away than when it is at hand. These and other valuable features of electrical methods of regulation are being realized by other industries and are being applied to bring about great advances in these arts. What has heretofore been done by rule of thumb is now being done scientifically. In many processes we are no longer dependent upon a good guess for good results, but we know what conditions must be maintained, and we know when this is being done; hence a good product must be obtained. Progress in such applications of electrical methods will undoubtedly go forward rapidly in the future. Indeed, it may form one of the noteworthy features of the electrical development of the next few years. The other industries are coming to a realization of the opportunities before them. They know their needs. Let them make them known and the electrical artisans will doubtless be able to offer the wished-for device or method.

TELEPHONE ETIQUETTE.

The telephone, indispensable as it is, is frequently a source of considerable irritation. The blame does not, of course, belong to the instrument, but is due to the lack of consideration of certain users of it.

Attention has been called again and again to that discourtesy, not at all infrequent, of getting the office boy or minor clerk to call up a busy man, who is then asked to hold the line until the person wishing to speak to him finds it convenient to do so. A good punishment for such a boor is to hold the line until he is ready to talk, and then ask him in turn to hold it for a few moments.

Irritating as the above treatment may be to the person who is called up by the telephone, it is not more so than that not seldom received by one who wishes to call up another person. In the modern business office, a private board operated by a clerk has become a necessity. It is the business of these clerks to receive all telephone calls and to distribute them to the proper persons in the office. It is the custom in some offices thus equipped for the clerk to find out who is calling up, so as to inform the person to whom he wishes to speak. But this information is not always transmitted, with the result that the caller is forced to state who he is to two or three individuals in turn. This not only wastes time, but is exceedingly annoying. The person in charge of the local board should not only be authorized to call up directly every one in the office, but when he asks who the caller is, he should not fail to transmit this information to the person called, and the latter when so informed should not repeat the question unless he be in doubt. Even then he should word it so that a single word in reply would be sufficient. Nothing is more exasperating when trying to reach a friend than to be called upon to tell who you are again and again only to be referred to another clerk who again asks "who is it?"

A POINT FOR THE PURCHASER.

The purchase of improved equipment in these days almost always implies the desire on the part of the buyer to obtain the utmost advantages possible from his physical plant, so that his production economy may be increased through the reduction of operating expenses per unit of output. It is often possible for a purchaser who has expended a large sum of money for the most modern machinery to turn that equipment to good account for advertising purposes, informing his customers of his improved methods of doing business through small descriptive booklets illustrated by pertinent photographs and by encouraging visitors to inspect his premises. The growing public interest in electrical appliances renders this an easy task in retail houses making wide use of electric motors or special lighting equipment, and there is no doubt that many purchasers of such machinery do not as yet appreciate the possibilities in this direction.

The advantages of electric lighting and power over gas, oil and antiquated shafts and belts are so striking that it is a pity for a merchant who has paid the price of such improvements not to turn them to account in every possible way. An electrically driven and heated laundry offers a fertile field for advertising suggestiveness; a motor-driven bakery appeals at once to discriminating customers as a cleanly establishment in comparison with older houses; while a finely lighted store or office is its own index of progressiveness. If some of the engineering salesmen in the district offices of the large companies would bring this matter home to their customers, it is safe to say that even greater satisfaction and profit would be obtained from modern equipment by its purchasers.

A SIMPLE HIGH-TENSION INSTRUMENT.

In a paper presented recently by Mr. D. Owen to the Physical Society, of London, there is a suggestion which may be useful. The paper itself described the use of an oscillating "electric needle"—a light conducting body suspended so as to be free to move when subjected to the forces set up in an electric field—for comparing electric fields. Its use here is similar to that of a vibrating magnet when measuring magnetic fields. When the needle is small and is placed between two parallel plates, the period of vibration is directly proportional to the voltage between the plates. An instrument as simple as this might be very handy when other apparatus is not available. While not direct reading, the ease with which it could be constructed in an out-of-the-way place would compensate for many disadvantages.

SUGGESTIONS FOR STEAM ECONOMY.[1]

BY WILLIAM MC KAY.

Almost every engineer and electrician is familiar with the fact that the majority of steam-power plants are not operating under the most economical conditions. In some cases this is due to the plant having been built up piecemeal as the requirements developed and in other cases it has been found difficult to determine the amount of power that would actually be required until after the plant was completed. If the consulting engineer could be informed, or could determine in advance the exact requirements for the present and future, it would be comparatively a simple matter to design the plant with fair accuracy as to the size and number of units, types of engines, boilers, and other details.

Although it is difficult to give any general information on this subject which will be of use or interest in the great variety of particular cases in which the members of this association are interested, it may be of some interest, and possibly of assistance to those who are managing or operating power plants, to discuss some of the principles upon which economy in the use of steam depends.

Beginning with the boiler, which is the first step in the production of power from fuel, it may be laid down as a good rule that it is more economical to use boilers of reasonably large size than to subdivide into a larger number of small units. The length and area of grate that can be conveniently fired or kept evenly covered with coal is, perhaps, the limiting feature, if hand-firing is to be used. Working from this rule, a grate should not be over seven feet long or more than five feet wide, which would give thirty-five square feet of grate surface. The quantity of coal that may be burned on such a grate varies widely with the kind of fuel and strength of draft. Using bituminous slack coal of fair quality, with good natural draft or moderate-induced draft, it should be possible to burn twenty-five pounds of coal per square foot of grate per hour, or 875 pounds of coal per hour, and if this coal will evaporate say eight pounds of water per pound of coal, the boiler, if constructed with heating surface in proper proportion, would evaporate 7,000 pounds of water per hour, which would be equal to a little over 200 standard boiler-horse-power. In order to give good economy, the boiler should have from 2,000 to 2,400 square feet of heating surface to evaporate this quantity of steam economically. The return tubular boiler, on account of the amount of tube surface in proportion to the direct surface exposed to the fire, should have not less than twelve square feet per horse-power; the water-tube type from ten to eleven, and the internally fired type, which has a larger amount of direct heating surface in the furnace and tubes than either of the others, should have nine to ten. If the grate surface is larger than that described, probably the grate will not be evenly covered with coal, or the fire will be dead in spots, so that too much cold air will pass through.

The economy in burning fuel is a matter requiring great skill and experience, and depends entirely upon the evenness, thickness and condition of the fire, which controls entirely the air supply and, therefore, the perfection or imperfection of the combustion, and I would say just here that there is very little use in "splitting hairs" over a quarter of a pound of steam consumption of the engine, while the fireman may be losing ten times this quantity of fuel from inefficient boilers or poor firing.

I fear it is too often the case that the demands for increased horse-power are met by grate surface too large in proportion to the heating surface of the boiler or forced draft, and too little attention is given to careful firing, with heating and grate surfaces in proper proportion to give best economy, and frequently a great deal of money is spent in obtaining high-class engines and condensers, whereas the principal loss is in the boiler and fire room.

The question is often asked whether in case of installing a certain horse-power of boilers, say 300 horse-power, it would be more economical to have three boilers of 100 horse-power each or two boilers of 150 horse-power each. I would say by all means have the two larger units, as it will always be found that the larger boilers have less radiation, less air leakage and better combustion than a corresponding horse-power in small units. If it is necessary to have a spare unit for cleaning, let there be another one provided of the same size.

In regard to the pressure to be carried. It is well known that a high pressure gives a greater amount of expansion and better economy in proportion to the fuel burned. Even with simple engines in which it is not possible to obtain the full advantage of expansion, the high pressure of steam, which is drier and contains a larger number of heat units in proportion to the volume, gives the best results. I think every boiler should be designed for not less than 150 pounds pressure per square inch. Even if it is not possible to utilize the full pressure, the boiler will be stronger, last longer and a better investment in the long run. In this respect, the water-tube or some form of internally fired boiler in which the shell plates are not exposed to the high temperature of the furnace are certainly safer than the horizontal return tubular boiler, because for large units intended to carry high pressure, the shell plates and seams must be of considerable thickness, and being directly exposed to the hottest part of the fire, are almost sure to give trouble, especially if there be any scale or sediment in the water which is liable to settle on the bottom directly over the fire.

As to the economy of various types of boilers, experience shows that any of the standard types, horizontal return tubular, water-tube, or internally fired, if they are designed with proper proportions of heating and grate surface, give about the same evaporation per pound of coal, provided they are in good condition and clean both on the fire and water surfaces. While the externally fired boilers, either of the return tubular or water-tube type, are said to have some advantage in combustion, on account of the heat of the brick furnace, they are subject to losses which are more serious, in the way of air leakage and radiation. Tests made at the Ohio State University, by Professor Hitchcock, show that the brick-setting of boilers continues to absorb heat up to seventy-two hours after being started, and that the average waste of heat in brick furnaces is about eight and one-half per cent. As the members of this association well know, the repairs and cost of keeping up brick furnaces is considerable, and as a result of deterioration there is more or less air leakage through the brickwork going on constantly. In this respect, the internally fired boiler has a great advantage over return tubular or water-tube boilers with brick furnaces, as it will be just as efficient after continued use as when first started.

In any type of boiler it is of great importance to keep the tubes and other surfaces free of soot and scale. Otherwise, a large loss may be sustained. I think it is a mistake to depend entirely on the steam blower or tube cleaner, which only removes the loose soot, a scraper being necessary for occasional use to free the hard scale, which will in time accumulate on the fire surfaces. It is necessary to point

[1] A paper read at the convention of the Canadian Electrical Association, Montreal, Canada, June 21, 22, 23, 1905.

out that scale, or worse still, oil on the inside of a boiler may be a source of great loss, experience having proved that even a thin film of oil will so prevent the transfer of heat that the plates or tubes will be burned in a very short time. Nothing but pure water should be used for making steam, and the practice of making the boiler do duty as a water purifier as well as a steam generator can not be too strongly condemned. If the owners of steam plants could be made to realize that a very small deposit of soot on the outside and scale on the inside means a loss of from ten to twenty per cent of the total fuel consumption, costing, perhaps, thousands of dollars per year, they would be convinced that it would be much cheaper to spend money in purifying apparatus, so that the scale or sediment will be removed before the water is fed to the boiler.

The next step to be considered is the heating of the feed water. This may be accomplished in two or three ways: first, by means of the exhaust steam, which, coming from a non-condensing engine, is capable of heating the feed water to 212 degrees and of saving say twelve to fifteen per cent as compared with feeding cold water. For large plants where it would pay to use induced draft to make up for the loss in temperature of the chimney gases, which produce the draft, it will undoubtedly pay to use an economizer, but as this apparatus is expensive both in first cost and up-keep, the amount saved in utilizing the waste gases from a small plant would probably not offset the outlay. The closed type of feed-water heater is about as efficient as the open type, provided the water is pure and it avoids trouble from pumping hot water, but the open type is frequently made use of to assist in purifying the water and, if properly managed, may give good service in that respect. For condensing engines, a primary heater of the closed type may be installed between the engine and condenser, which will help to condense the steam and heat the feed water to a low temperature, say 130 to 140 degrees Fahrenheit. A secondary heater, either of the closed or open type, may be used to heat the feed water to a still higher temperature, say 212 degrees, by the use of the exhaust from the feed and air pumps, which can not be used more profitably than in this way, as all the heat is returned to the boiler.

In regard to the type of engine used for the plants: if the size of the plant is sufficient, and the work comparatively steady, the highest possible results may be obtained from compound condensing engines using the highest possible pressure of steam, but under other conditions, such as variable load, low pressure of steam, it may be quite possible that the simple engine will give better results and cost less for repairs. With low steam pressure, non-condensing, there is certainly nothing better or more economical than a single-cylinder Corliss engine where it can be installed to advantage. In the case of direct-driven electric units of small size, it is necessary to use high or medium speed engines, both on account of the loss in friction that would come in if countershaft and belting have to be used and because the higher speed machines will give the best regulation. For small units up to say seventy-five or even 100 horse-power, there is nothing better than the modern high-speed automatic engine, provided it is of good design, not overloaded and not overspeeded. A well-designed engine with twelve-inch cylinder and twelve-inch stroke, which is usually run at 275 to 300 revolutions per minute, and made to develop from seventy-five to eighty horse-power, if arranged to run at say 225 to 250 revolutions per minute and to carry fifty or sixty horse-power, will be as serviceable and give as good results as any type of engine of the same horse-power under ordinary conditions non-condensing, and if the work is variable, requiring quick, close regulation, such as driving electric generators, where the load is irregular, say for supplying current to electric lights and electric elevators, the short-stroke, single-valve type of engine has great advantages.

As illustrating the small wear of high-speed engines under favorable conditions, a Robb-Armstrong engine of twelve-inch stroke, which has been running at 275 revolutions per minute for electric lighting for twelve or fourteen years, shows only about two-thousandths of an inch wear of the journals, and six-thousandths of an inch wear in the shaft bearings.

Unfortunately, this class of engine is so frequently overloaded and overspeeded that it gives poor results and gets a bad name, whereas the Corliss slow-speed type of engine is limited both in the matter of speed and horse-power, because the cut-off of the single eccentric type will not go much beyond half stroke, and in that way the engine is saved from overloading and abuse, and this is, perhaps, one of its many advantages. A compound engine is not suited to low pressure or irregular loads and the extra cylinder and complication of parts is a great objection under such conditions. When a condenser is used, even with low pressure and somewhat irregular loads, it may be employed to advantage and with high pressure, say from 125 to 150 pounds or over, the non-condensing compound will give the best results, unless the load is very irregular and running to light loads a large part of the time.

The question is sometimes asked whether it pays to reduce the pressure when the load is light. From my experience, I do not believe it pays to reduce the pressure on the boiler, excepting in very extreme cases, but if it can be done by throttling before the steam reached the cylinder of the engine, it would be an advantage, because this retains the heat units due to the higher pressure in the steam and the throttling has a slight superheating effect. As a matter of fact, tests made by Willans & Robinson, of England, go to show that for light loads and high pressure, a throttling engine may do even better than automatic cut-off. The ideal arrangement is to throttle the steam for light loads up to say near quarter cut-off, and after that, for heavier loads, allow the variable cut-off to come into play. This practice has been carried into effect by the design of Mr. E. J. Armstrong, in which he arranges the shaft governor so that there is negative lead up to nearly one-quarter cut-off, after which the lead becomes positive, and this has the effect of throttling the steam for the earlier loads and undoubtedly gives better economy, in addition to making the engine run more quietly.

Another source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

In general, it may be said that the principal cause for loss in steam plants is the use of engines which are overloaded or unsuited to the conditions of work, undersized, or badly arranged steam and exhaust pipes, and the imperfect condition and poor operation of the boilers. In many plants, exhaust steam, which might be utilized for heating, is wasted, and in others, where the exhaust steam is utilized for heating, power is wasted by excessive back pressure. The most economical use that exhaust steam can be put to is for heating, because all the heat units are made use of, but it should be done without back pressure on the engine, by means of a vacuum system to draw the steam and water through the heating pipes, otherwise there will be a loss both of fuel and power, due to the engine working under imperfect conditions.

Some of the Electrical Developments in Oregon.

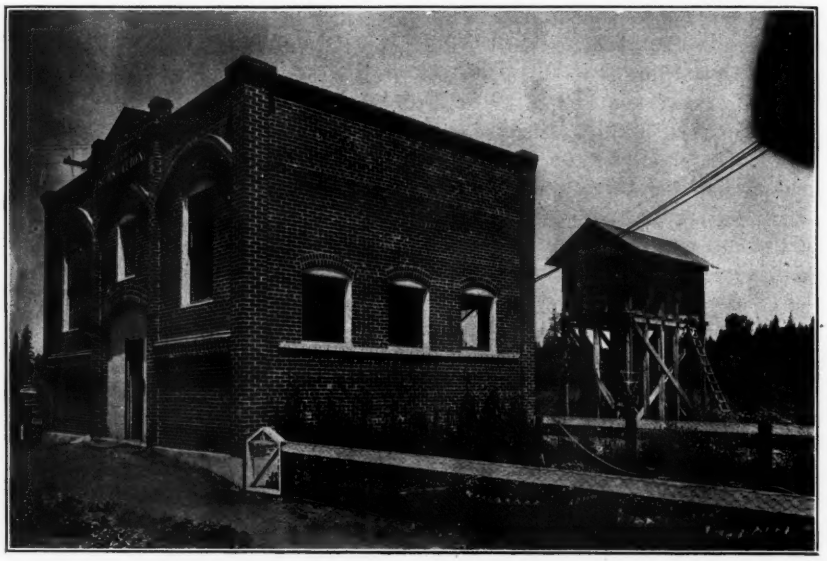
The Utilization of Water Power in the Northwest.

By C. M. Hyskell.

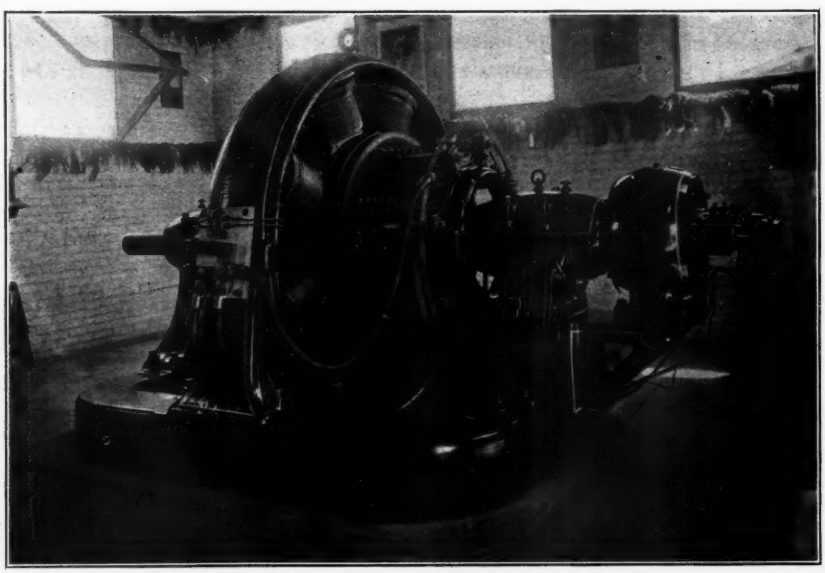
IT IS claimed for Oregon that it has greater aggregate and better distributed water powers than any other state in the union, for commercial uses. This power, until the last two or three years, has been almost totally neglected. It is now receiving attention from many sources where capital is linked with plans for development, and there is an excellent prospect that within the next few years Oregon will receive heavy accessions to the money that is invested here in electrical enterprises.

The largest project now under way is the plant of the Oregon Water Power and Railway Company, at Cazadero, on the Clackamas river, forty miles from Portland. The company is expending $750,000 in construction of a plant that will generate 20,000 horse-power. Riparian rights on the Clackamas for two and one-half miles were secured, a concrete dam, and a canal sixty feet wide and five feet deep has been built to a length of 4,000 feet. In that distance a fall of 125 feet is secured. The design of the company is to turn the water back into the river, repeat the dam and canal proposition as many times as may be found necessary along the river within the limits of its rights, and thus develop more power in future as the demand arises. The first dam and canal are about completed, and the plant will be ready for operation by January 1, 1906. Five or six generators, each of a capacity of 2,500 kilowatts, will be installed and current will be stepped up to 34,000 volts for transmission to Portland by three pole lines—one for railway feeders and trolley, and two for high-tension transmission.

The Oregon Water Power and Railway Company now operates an electric railroad system of 100 miles, standard gauge track, and handles interurban and urban passenger traffic, and standard freight cars. It contemplates the production of power for additional mileage, and for commercial purposes. The lines of the company now connect Portland with Sellwood, Oregon City, Milwaukee, Canemah, and Cazadero, and an extension of seven and one-half miles to Troutdale, on the Columbia river, has been decided upon. A contract has also been made to furnish power to the Portland General Electric. An electric road now under construction by the Oregon Traction Company from Portland to Hillsboro and Forest Grove, twenty-six miles, will not erect its own power plant, but will probably purchase power from the Cazadero plant. The Oregon Water Power and Railway Company has demonstrated a complete success in electrical operation of a mixed proposition of street car, interurban and heavy freight traffic lines, extending out from its centre in Portland, through a rough country surrounding this city, in a radius of fifty miles. The company began operations in 1900, when it acquired from receiverships two east Portland lines of street railway, and combined them with the original line running to Oregon City, sixteen miles. Extensions and all kinds of betterments have been rapidly made, the system meantime being operated by current generated in steam plants at Boring and in Portland, with substations at Gresham and Eagle Creek. The Boring plant consists of one Stanley 600-kilowatt, three-phase, 12,000-volt, thirty-three-cycle, star-connected generator, direct-connected through a flexible coup-



EAGLE CREEK SUBSTATION OF THE OREGON WATER POWER AND RAILWAY COMPANY.



ROTARY CONVERTER, GRESHAM SUBSTATION, OREGON WATER POWER AND RAILWAY COMPANY.

ling to a steam-driven line shaft; and one 200-kilowatt, belt-driven, direct-current generator, with the necessary engines and boilers to take care of these generators. Rope transmission is used between engine and line shaft. The plant is operated with sawdust as fuel, from a nearby mill, and very economical results are obtained. The equipment of the small plant at the Portland end of the line consists of five Babcock & Wilcox water-tube boilers, rated at 125 horse-power each, and one Corliss engine that is belted to a 600-kilowatt direct-current machine. The remainder of the current needed is purchased from the Portland General Electric. When the

THE CLACKAMAS NEAR CAZADERO, WHERE THE NEW PLANT OF THE OREGON WATER POWER AND RAILWAY COMPANY IS LOCATED.

Cazadero plant is completed the situation will be reversed and the company will sell power to the Portland General Electric. The Oregon Water Power and Railway Company taps a rich agricultural section, and on the Portland division alone are lumber mills that cut more than 600,000 feet board measure daily. Its terminals embrace a water frontage of about three miles on the Willamette river, where its docks afford facilities for loading ocean-going vessels.

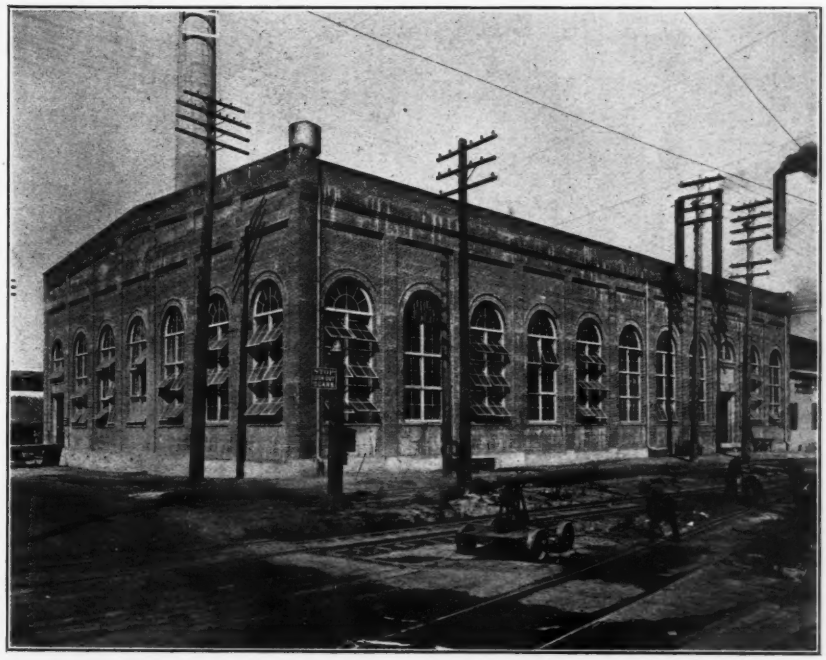
PORTLAND GENERAL ELECTRIC ENLARGEMENTS.

To supply 4,000 horse-power for lighting the Lewis and Clark exposition, and, besides, to meet the rapidly increasing demand for commercial electric lighting and power in and around Portland, the Portland General Electric has just completed the construction of a steam plant in this city, by which it will generate 10,000 horse-power, doubling the capacity the company now derives from its water-power plant at Willamette Falls, Oregon City.

The new plant, known as Station E, is a brick structure with a steel truss roof

BEGINNING CONSTRUCTION ON THE DAM AT THE CAZADERO POWER PLANT OF THE OREGON WATER POWER AND RAILWAY COMPANY.

covered with tar and gravel roofing. The engine room is 46 by 160 feet, separated from the boiler room by a twenty-four-inch curtain wall, provided with fireproof doors. There is a stack 230 feet



STATION "E," PORTLAND GENERAL ELECTRIC COMPANY.

high, of concrete steel construction, with twelve feet inside diameter. There are five batteries of Cahall water-tube boilers, from the Aultman & Taylor Company, each battery having a rating of 1,040 horse-power, 175 pounds pressure. Three of the batteries are equipped with Foster superheaters, built to superheat the steam to 175 degrees.

One end of the boiler room has been reserved for a pump pit, in which are installed three Worthington horizontal centrifugal turbine pumps, driven by vertical engines, and which are used for pumping the condenser cooling water from the river through the condensers. Two lines of thirty-three-inch cast-iron pipe are run to the river for the purpose; one for the suction and the other for the discharge. In addition to these pumps, three Blake

outside packed plunger pumps are provided for feeding the boilers. The suctions of these pumps can be taken either from the discharge of the circulating water, as it comes from the condenser, or directly from the river. Arrangements have been made so that in case either of these two sources of supply should fail, the water can be forced into the boilers from the city main. The plant is also provided with three Goubert feed-water heaters.

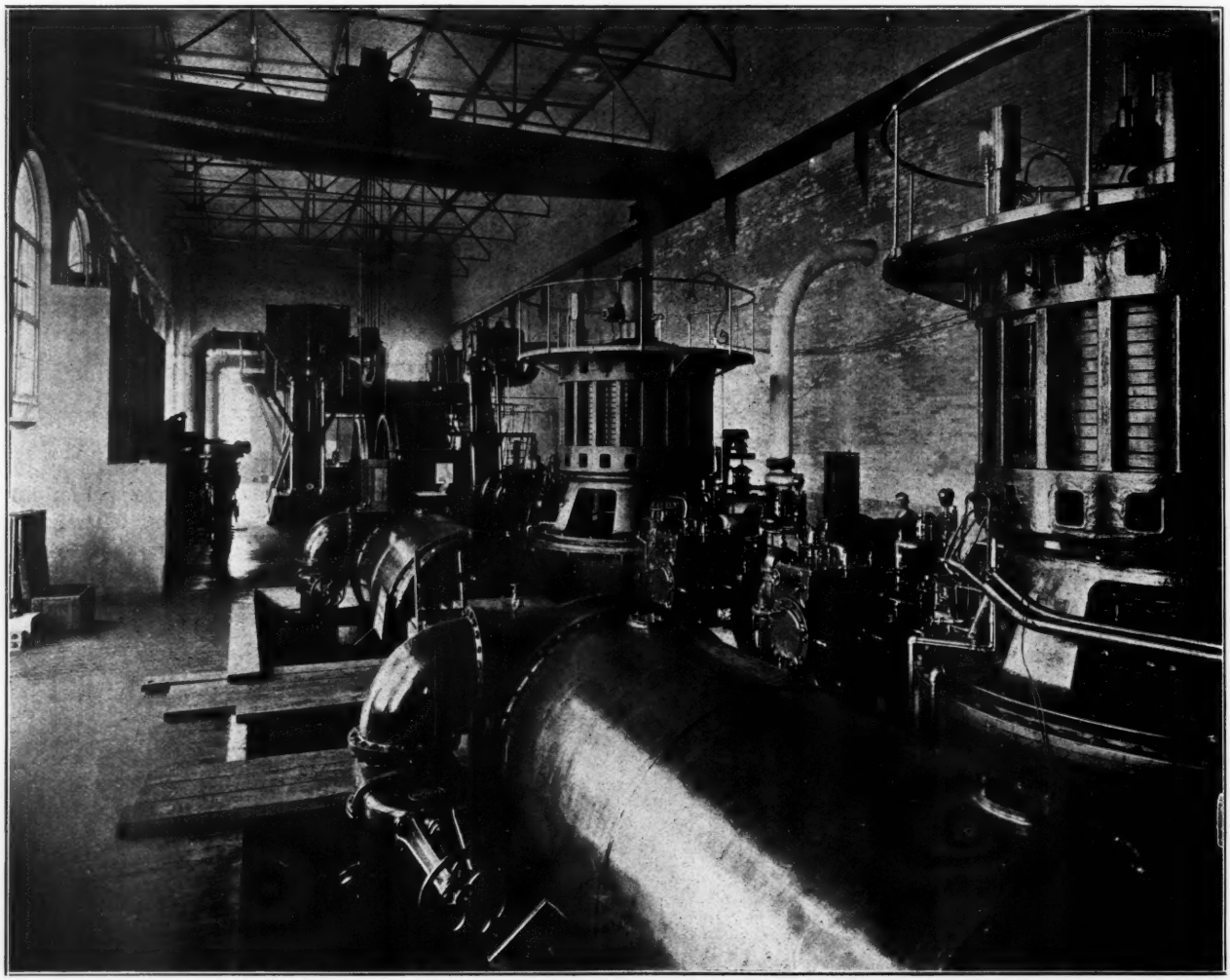
All of the steam piping was furnished by M. W. Kellogg & Company, and installed partly by the Willamette Iron and Steel Company and partly by the Portland General Electric Company. The high-pressure steam piping is made extra heavy, of lap-welded mild open-hearth steel, and Vanstone joints are used. All low pressure piping, except the free exhaust from the engines outside of the relief valves and the free exhaust from the feed-water heater, is of standard weight wrought-iron pipe, the free exhaust above mentioned being riveted sheet-iron pipe. The piping is arranged so that any part of the plant can be isolated when desired.

The boilers at Station E are arranged so that they can either burn oil or sawdust, and are provided with Dutch ovens, there being two ovens under each boiler, or four ovens per battery. Each oven is provided with two Morrissey oil burners, so arranged, by means of unions in the steam and oil piping, that the burners can be quickly and easily disconnected when it is desired to use sawdust. A storage tank is provided outside of the station and underground of sufficient capacity to hold two and one-half car loads of oil. This oil is pumped to the burners by means of a pressure pump, built by the Portland Machinery Company.

The main fuel used in the station, however, is the sawdust, obtained from the Eastern Lumber Company and the North Pacific Lumber Company, which are located close to the station. This sawdust is transported to the station by team and dumped into a hopper. From this hopper, by means of a conveyer, it is carried to the fuel house. There the conveyers take the sawdust and carry it to the boilers at either Station C or E, as desired, where it is fed into the top of the Dutch ovens. A remarkably hot fire is thus furnished, at a low cost.

The generating equipment of Station E consists of two 1,400-horse-power marine type, vertical compound engines, built by the Willamette Iron and Steel Works, of Portland. Each of these engines is direct-connected to a 1,000-kilowatt, thirty-three-cycle, three-phase General Electric alternator, one Ideal engine exciter of eighty-five kilowatts capacity, one motor-generator exciter of sixty kilowatts capacity, two Curtis steam turbines, each rated at 1,500 kilowatts, but good for 2,000 kilowatts continuously.

The condenser system of Station E consists of two Worthington surface condensers, each having 2,300 square feet of



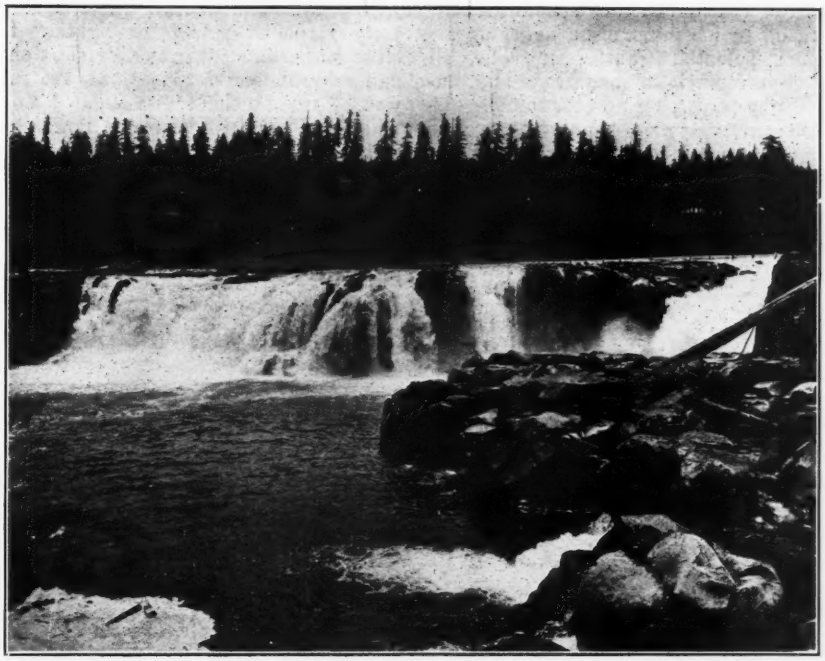
ENGINE ROOM OF STATION "E," PORTLAND GENERAL ELECTRIC COMPANY.

cooling surface, and two Worthington surface condensers having 7,800 square feet of cooling surface, the latter being used for the Curtis turbines. These condensers are provided with air coolers and hot wells, and with the necessary dry vacuum and hot-well pumps. The turbines are also provided with two outside packed plunger pumps for forcing the water into the step bearing at a pressure of 450 pounds per square inch. An accumulator is also used in connection with these pumps.

The oiling system for the engines consists of White Star oil filters, and for the turbines of two tanks, one placed near the roof and the other in the basement, the oil being pumped into the tank near the roof by means of small plunger pumps and allowed to run through the turbine bearings by gravity.

The piping arrangements are such that water from the condenser hot well can be used for the end step-bearings of the turbines, the surplus water not used for these being fed through the heaters back to the boilers.

The switchboard in Station E is com-



WILLAMETTE FALLS, FURNISHING POWER FOR OREGON CITY PLANT OF PORTLAND GENERAL ELECTRIC COMPANY.

GENERATING PLANT OF STATION "E," PORTLAND GENERAL ELECTRIC COMPANY.

posed of General Electric apparatus, bus-bars, oil switch mechanism, lightning arresters, potential transformers, etc., all placed in concrete compartments, and controlled by panels, placed at a suitable distance in front of these compartments. The remote control is used on all high-tension switches. All generators are connected to the switchboards by means of cambric insulated cables, drawn into ducts under the floor. The feeder wires leave the building through pipes and run out underground.

Reservoir and Penstock, Northwestern Gas and Electric Company, Walla Walla Plant.

The Portland General Electric Company furnishes power for lighting the cities of Portland, Oregon City, St. Johns and suburbs, and for operating the railway of the Portland Consolidated Company, and the Oregon Water Power and Railway Company, and also for operating the Portland Flouring Mills and for other manufacturing purposes near at hand. The generated current is three-phase, thirty-three cycles, 10,000 volts, and can be furnished either from the water-power plant at Oregon City, known as Station B, or from the new steam station, located in Portland, known as Station E. This power is led to the substation in Portland, known as Substation A, and located at the corner of Seventh and Alder streets, where part of it is changed by means of static transformers from 10,000 to 2,300 volts, to be used for lighting purposes, and is distributed throughout the city of Portland at this voltage, and at frequency of thirty-three cycles over single-phase circuits. The rest of the current for lighting purposes is transformed by means of motor-generator sets from three-phase, thirty-three cycles, 10,000 volts to three-phase, sixty-cycle, 2,300-volt current, which in turn is distributed throughout the city by means of single-phase circuits.

Northwestern Gas and Electric Company, Hoisting Traveler on the Mountainside, Walla Walla Plant.

The lighting of the station is so arranged that the light can be furnished either from the 500-volt direct-current railway current or the sixty-cycle alternating current. The station is equipped with a twenty-ton hand-operated traveling crane, with a hoist arranged to operate electrically.

The street arc lighting is accomplished at the present time by Thomson-Houston direct-current open arcs, furnished with current from the original Excelsior arc machines, which are operated by means of motors driven from the 500-volt, direct-current railway machines.

Power is furnished to the street railway system from Oregon City, and is conducted by means of individual transmission circuits to five 400-kilowatt rotary converters, and one 1,000-kilowatt rotary converter, located at Substation A. This power is furnished to the Portland Consolidated Railway Company at a pressure of 550 volts at the bus-bars, it providing the necessary feeders, etc., for distributing it to its trolley wires.

The power or Flour Mill circuit is operated at about 6,000 volts, over a three-phase, thirty-three-cycle circuit. It is intended, however, to change this in the near future to operate at 10,000 volts.

NORTHWESTERN GAS AND ELECTRIC COMPANY'S NEW PLANT.

A water-power plant for producing electric light and power current, remarkable for the scenic wildness of its location, has just been completed on the Walla Walla river, in Umatilla County, Oregon. Light is now being supplied from it to the cities of Walla Walla, Weston, Athena and Pendleton. The capacity of the plant is 3,000 horse-power. From the dam and point of intake at the river water is carried through a forty-eight-inch wood stave pipe five and a half miles to a reservoir on a mountainside, where it falls 356 feet to the wheels. The construction of this plant was very expensive and difficult owing to the fact that it was a long way from the centre of supplies, and all material had to be hoisted up the mountainside by donkey engines. There was a great deal of excavating for the bench on which the pipe rests; also many cañons to be crossed by trestles. Inverted siphons are used, and some of them have 170 feet head.

The company will build a street car line in Walla Walla and extend it into the surrounding country. A 600-barrel flouring mill at Athena is being operated with power from the plant.

GOLD RAY POWER COMPANY PLANT.

Colonel Frank Ray, of New York, and Dr. Ray, of Grant's Pass, Ore., have constructed a dam and power plant on the Rogue river at Gold Ray, and are stringing wires to furnish light and power to the cities of Grant's Pass, Gold Hill, Tolo, Medford and other points in the valley. The plant generates 5,000 horse-power, and it is the purpose of the owners to furnish power for operating stamp mills and other mining plants in southern Oregon.

THE ORGANIZATION AND ADMINISTRATION OF NATIONAL ENGINEERING SOCIETIES.[1]

BY JOHN W. LIEB, JR.

The most important factors in promoting the advance of the engineering profession, and in disseminating and rendering available to the world the valuable experience and data accumulated by engineers, are the professional associations or national engineering societies. The importance of interchange of data, and results of observation and experience, was realized long before the practice of engineering had been exalted to the dignity of a profession.

While military engineering was recognized as a special calling from the earliest times, and great military engineers such as Vauban, and bridge and highways engineers such as Perronet, had achieved eminence, it was manifestly impracticable for military men to associate for the purpose of interchanging information, on the secrecy of which the military establishments of nations were dependent for their offensive and defensive efficiency. The first important step for associating engineers into a professional body was taken in 1828 by Thomas Telford, who applied for royal charter for the Institution of Civil Engineers, of Great Britain, in the name of 156 of his colleagues, some of whom had already formed a society as early as 1818. The original charter recites that the body is formed: "for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns."

It will be seen that this comprehensive, and now historic, definition of the field covered by the profession of the civil engineer, as formulated by Tredgold, includes broadly all branches of modern engineering science, except military engineering, and, directly or by implication, includes within its scope mechanical, mining, electrical, and sanitary engineering, and naval architecture. It was long before important discoveries in the realm of physical science, and epoch-making inventions and improvements in the mechanical arts opened new fields of industrial activity, which broadened the field covered by the engineer, and were reflected in a differentiation of the profession, resulting, in Great Britain, in the organization of the Institution of Mechanical Engineers in 1847, the Iron and Steel Institute in 1869, and the Society of Telegraph Engineers and Electricians in 1871, which, in 1889, became the Institution of Electrical Engineers.

Coming now to our own country, the American Society of Civil Engineers was organized in 1852, the American Institute of Mining Engineers in 1871, the American Society of Mechanical Engineers in 1880, and the American Institute of Electrical Engineers in 1884. While these are the distinctively national engineering societies, there are other technical associations like the Society of Naval Architects and Marine Engineers, the American Society of Heating and Ventilating Engineers, the American Street Railway Association, etc., which, although of national importance, do not come within the scope of this address.

There are many other professional bodies in the United States also identified with the engineering profession, some of them of a national character, which, in addition to professional activities, are organized for commercial relations, and whose members consist largely of business corporations. To this class belong the National Electric Light Association and the Association of Edison Illuminating Companies.

There are also others that are largely local in character, such as the Pacific Coast Transmission Association, the Engineers' Society of Western Pennsylvania, and the league known as the Association of Engineering Societies, which represent a total membership of 1,766, in eleven local engineers' clubs or societies.

In this review we shall confine our attention to the four national engineering societies first referred to, with some reference to the corresponding bodies in Great Britain and on the Continent.

The membership of these bodies, divided into classes according to the last official reports, is given in the following table; as a matter of general interest there is also added a corresponding tabulation of the more important European engineering societies.

FOREIGN ENGINEERING SOCIETIES.

Name and Date of Organization.	Date of Report.	Honorary Members.	Full Members.	Associate Members.	Associates.	Total.
Institution of Civil Engineers (of Great Britain), 1818.....	Jan. 1, 1905	19	2191	4116	271	*6597
Institution of Mechanical Engineers, 1847.....	Mar. 1, 1905	9	2351	1545	72	†3977
Iron and Steel Inst., 1869.....	Jan. 1, 1905	11	1898	....	....	1909
‡Institution of Electrical Engineers, 1889.....	Aug. 31, 1904	6	*1101	1435	1761	‡4303
Verein Deutscher Ingenieure, 1891.	Apr. 24, 1903	6	17543	....	....	17549
Société des Ingénieurs Civil de France, 1848.....	1901	..	....	....	....	3691

*Includes 136 foreign members.
*Not including 1144 students or graduates.
†Originally organized as the Society of Telegraph Engineers and Electricians in 1871.
†Not including 450 students or graduates.
‡Not including 1107 students or graduates.

NATIONAL ENGINEERING SOCIETIES (U. S.).

Name and Date of Organization.	Date of Report.	Hon. Members.	Full Members.	Associate Members.	Associates.	Junior Members.	Total.
American Society of Civil Engineers, 1852	Jan. 1, 1905	9	1795	903	127	*367	3203
American Institute of Mining Engineers, 1871	Jan. 1, 1905	7	3483	....	190	...	3680
American Society of Mechanical Engineers, 1880.....	Jan. 1, 1905	19	1915	....	237	609	2780
American Institute of Electrical Engineers, 1884	Jan. 1, 1905	2	481	2851	...	...	3334

*Including 27 fellows.

A study of the annual reports of these bodies and of their constitutions and by-

[1] Presidential address presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, N. C., June 19-23, 1905.

laws is of considerable interest, as showing their progressive expansion, growing influence, and higher professional standing from year to year, and the lines along which these developments take place. We shall not undertake a retrospective analysis, however, but rather confine ourselves to a comparative study of the methods of organization and business administration of the four national engineering societies, as revealed in their last annual reports.

It should be stated at the outset that this study is not undertaken with the view of criticising the methods followed, or results accomplished by our sister societies, but for the purpose of profiting by their experience, and, if possible, avoiding in our own rapidly growing body any abnormal development which may detract from its efficiency as a whole, or result in purely local development at the sacrifice of general usefulness and national standing.

One of the first questions we encounter is the grades of membership, then the requirements of admission to them, and the method of election. These questions are of fundamental importance and are worthy of the closest attention because upon them more than upon any other feature of the organization must depend the professional standing of the society and its healthy growth in membership and influence. There is no honor within the gift of the society that requires the exercise of so much judgment, such fidelity to its interests, such conscientiousness, impartiality, and impersonality as membership on the board of examiners or committee on admissions, and it is deserving of the highest recognition.

The requirements for honorary membership demand no lengthy discussion, as the practice of all societies is essentially identical in this respect.

The requirements for full membership vary greatly in the four societies, as we shall see from abstracts from their constitutions.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

CONSTITUTION—ARTICLE II—MEMBERSHIP.

2. A member shall be a civil, military, naval, mining, mechanical, electrical, or other professional engineer, an architect or a marine architect. He shall be at the time of admission to membership not less than thirty years of age, and shall have been in the active practice of his profession for ten years; he shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering works. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice. The performance of the duties of a professor of engineering in a technical school of high grade shall be taken as an equivalent to an equal number of years of actual practice.

AMERICAN INSTITUTE OF MINING ENGINEERS.

CONSTITUTION—ARTICLE II—MEMBERS.

SEC. 3. The following classes of persons shall be eligible for membership in the Institute; namely, as members all professional mining engineers, geologists, metallurgists or chemists, and all persons practically engaged in mining, metallurgy or metallurgical engineering.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

CONSTITUTION—MEMBERSHIP.

C 9. A member shall be thirty years of age or over. He must have been so connected with engineering as to be competent, as a designer or as a constructor, to take responsible charge of work in his branch of engineering, or he must have served as a teacher of engineering for more than five years.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

CONSTITUTION—ARTICLE II—MEMBERSHIP.

2. A member shall have been an associate, and at the time of his transfer to membership he shall be not less than twenty-seven years of age, and shall be:

a. A professional electrical engineer; or

b. A professor of electrical engineering; or

c. A person who has done important original work, of recognized value to electrical science.

3. To be eligible to membership, as a professional electrical engineer, the applicant shall have been in the active practice of his profession for at least five years; he shall have had responsible charge of work for at least two years, and shall be qualified to design as well as direct electrical engineering works. Graduation from a school of engineering of recognized standing shall be considered the equivalent of one year's active practice.

4. To be eligible to membership as professor of electrical engineering, the applicant shall have been in responsible charge of a course of electrical engineering at a college or technical school of recognized standing for a period of at least two years.

It will be seen that two of the societies fix an age limit of thirty years, one of twenty-seven years, and one fixes no limit; one society requires professional practice for ten years, one for five years, and two set no limit; three of the societies require professional competency in designing as well as constructing or directing engineering works, and one requires the applicant to be professionally or practically engaged in the branch of engineering with which the organization is identified.

In the case of the mechanical engineers and the civil engineers the election is by ballot of the membership at large after approval by the executive board or council; in the case of the mining engineers and electrical engineers, election is by direct vote of the board of directors, in the latter after submitting the names to the membership at large, in the former without such submission. In the mining engineers, mechanical engineers, and electrical engineers the application is first passed upon by the board of examiners and then by the executive board or council; in the case of the civil engineers it is passed upon by the board of directors without action by an examining board. The electrical engineers' constitution requires that all members shall first be elected as associates, and then transferred by the board.

It will be seen from the above how different are the requirements for full membership in the several societies, and how varied is the procedure for election. It would seem at first thought that the more explicit the constitution in its exact definition of the conditions for membership the easier it would be for the membership committee to act, but this is by no means always the case, as it often prevents taking a broad view of the candidate's eligibility and is liable to exclude desirable material on technical grounds, although on the other hand it is a protection against loose interpretation of the requirements by careless examiners. It would seem that a better division of responsibility and a more direct control of the class of men admitted to membership ought to result by giving wide publicity to their candidacy and election by ballot of the membership at large, after the candidates have passed the scrutiny of the board or an examining committee. A young society covering a branch of engineering that has but recently become specialized can not in the beginning impose rigorous requirements as to age limit or time of professional service, and the branch of engineering may be such as to make it difficult to impose severe technical requirements.

In the case of the civil engineers the accepted definition is sufficiently broad to cover applicants who are professionally engaged in any of the other branches of engineering; the mechanical engineers' definition is somewhat less comprehensive; that of the mining engineers is still less so, while that of the electrical engineers is really restrictive to professional electrical engineers. Under our Institute's constitution, however eminent a man may be as a civil, mechanical, or mining engineer, he may not fulfil the qualifications of an electrical engineer. It will thus be seen that anything like standardization in the matter of requirements is wholly out of the question, although a greater uniformity in requirements and procedure for election would be advisable? It is difficult for an applicant in every respect qualified for full membership in our Institute to understand why it should be necessary for him to pass through the preliminary, or, as it were, probationary

grade of associate, and then be transferred to full membership, but the constitution is clear on that point. Applicants whose superior qualifications would entitle them to immediate election to full membership, after their election to the preliminary grade of associate—which would take some time, several months at least—are liable not to make application for transfer, with the result that many remain in the associate grade who should certainly be transferred, and when they find the cause of the delay are likely to criticise the administration.

We now come to the consideration of the other grades of membership, associate membership, associates, juniors, etc. It would lead us too far afield to treat each grade in full and we shall confine ourselves to some general observations. It is necessary to provide one or more grades for young men just entering professional life through which they can rise, as they acquire experience, to the dignity of full membership; but it is necessary also to provide for another class of men who, though not professional engineers, nevertheless cooperate with them, and conduct engineering works, while at the same time acting as executive heads or business managers. To such men, eminent in their particular branches of activity, it is humiliating to be placed permanently in an inferior grade of membership with the beginners in professional service; the situation could be satisfactorily met by establishing the grade of associate, junior, and associate membership, to represent successive steps in the advancement to full membership, the associates forming a class by themselves.

We now come to the question of dues, and at the same time we may with advantage consider the general question of income and expenses, or the cost of conducting the business of the societies.

The expense of membership in the several societies is as follows:

	Entrance Fees.			Annual Dues.			Foreign.	
	Juniors.	Associates.	Members.	Juniors.	Associates.	Members.	Associates.	Members.
American Society Civil Engineers	$10	$20-25	$30	$10-15	$10-15	$15-25	..	..
American Institute Mining Engineers	..	10	10	..	10	10	..	..
American Society Mechanical Engineers	15	25	25	10	15	15	..	..
American Institute Electrical Engineers	..	5	15	..	10	15	5	10

In view of the new relations entered into between the three national engineering societies that are to occupy jointly the Union Engineering Building, and as they now have roughly about the same membership, it would seem desirable to have membership dues as nearly uniform as practicable.

It is probable that the entrance fees of our Institute might be revised without disadvantage by increasing the entrance fee for associate to at least ten dollars, and requiring payment of an additional fifteen dollars on transfer, making a total of twenty-five dollars for full membership. An increase in annual dues, also, is not at all improbable in the near future, and they might with advantage be increased to fifteen dollars for resident associates (within fifty miles of New York) and to twenty-five dollars for resident members; this increase for resident membership would seem to be warranted by the greater advantages enjoyed by the members residing in or near New York, more especially after occupancy of the Union Engineering Building.

Let us now consider the annual receipts and disbursements per paying member per year in the four societies. These figures are presented purely as a matter of general interest and not at all for the purpose of invidious comparison; the table of receipts and disbursements per member is subdivided under appropriate heads as accurately as they can be compiled. These figures do not include extraordinary receipts and disbursements, but, as far as can be learned from the annual reports, they cover only the regular and ordinary items of income and expenditure.

RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER.

	Civil.	Mining.	Mechanical.	Electrical.
RECEIPTS.				
Entrance fees	$2.59	$0.28	$2.45	$0.83
Dues	16.99	10.64	14.04	9.30
Transactions, sales and advertisements	1.86	2.09	1.64	1.70
Badges and certificates	.65	....	....	.28
Interest	.36	.34	....	.21
	$22.45	$13.35	$18.13	$12.32
DISBURSEMENTS.				
Transactions	$4.63	$5.28	$7.50	$3.77
Salaries, etc	6.13	4.22	3.99	2.20
Meeting expenses	.29	.30	.94	.82
Library, including rent and salaries	.30	.80	.39	.81
Rent	2.84	.74	2.79	.75
Stationery and miscellaneous printing	.62	.34	1.19	.70
Postage	1.10	1.02	.26	.66
General expenses	.34	.47	.11	.54
Badges and certificates	.50	....	.33	.25
Express	....	.83	....	.22
Totals	$16.75	$14.00	$17.50	$10.72
Credit balance per member	5.70	.65	.63	1.60

It should be borne in mind that no deductions of value can be drawn from a comparison of these figures alone. Take the cost of the transactions for instance, in order to make a comparison of the relative economy with which this item is handled in the several cases, it would be necessary in each instance to know the number of pages and cuts, and the number of advance copies distributed at meetings, or monthly advance publications sent to members in addition to the regular annual volumes. The figures therefore represent the amounts which are being spent on the several items, rather than a comparison of their economic handling; it would be fallacious to assume that the figures necessarily represent the comparative economy with which the societies conduct their affairs as indicated by the items in the table.

It may also be interesting to compare the receipts and disbursements per Institute member within the past five years, during which the membership has increased from 1,260 to 3,460. (See page 234.)

Our next concern is with the officers of the societies and the methods of nominating and electing them. A truly national society should draw its membership from all parts of the country,

and should afford representation, through its officers and those on its administrative committees, to the membership at large; in other words, it should select its officers as far as possible with a view to their geographical distribution. It is admitted that this plan is difficult owing to the opportunities afforded to practising engineers by large enterprises, whose administrations, technical as well as financial, are generally located in the important commercial centres. For this reason the important groups of members are found in the large cities, and from them are drawn the majority of the officers, such selection being emphasized by the necessities of the central administration of the society. This procedure is liable, however, to operate to the disadvantage of candidates qualified for the important posts of honor within the gift of the societies that are open to be stationed some distance away from headquarters. To keep the Institute on the plane of national standing it should have a care to the broad geographical distribution of its officers. This end can best be accomplished by having a nominating committee, the several members of which are respectively selected from the same number of geographical groups of members of the society, each group to consist of, say, 300 or 400 members. Upon this committee, in consultation with a number of past officers, should rest the selection of the official nominees. Provision should also be made for the filing of such nominations as may be made directly by the general membership. This procedure was introduced by the American Society of Civil Engineers several years ago. Such a plan would provide geographical representation and at the same time discourage unseemly electioneering and advertising by circular for the coveted posts of honor. It is thought by some members that our own Institute could with advantage modify its procedure in this direction.

We would add further that it would be to the advantage of the interests of the Institute if the officers elect were to take office at the close of the annual meeting, or at latest as the last act of the annual convention. The supersession of the retiring president and officers and the installation of their successors should be an official function at a general Institute meeting, the lack of which in our present method of procedure allows four months to elapse after the election of officers before they assume their duties, and within three months, or at most four months, after taking office the active canvass for their successors is already under way.

It will be admitted by all who have had experience in the administration of professional societies that it is desirable to eliminate every tendency toward political agitation in connection with the election to honors within the gift of the membership, and to concentrate every effort upon advancing the professional standing of the society and the interests of its members. It would also seem of advantage to have the fiscal year coincide with the calendar year; this would lengthen the time between the annual meeting and the annual convention, and by spreading the time taken by the former over several days a larger attendance of the out-of-town members would be secured for the annual business meeting and the annual banquet, or for other functions which could be held in the time available. The annual meeting, as held at present, is not markedly distinguished from the other monthly meetings, and there is usually only a month between it and the annual convention. With the growing importance of the financial interests confided to the care of successive administrations the yearly business meeting should receive more attention, and the membership at large should participate in them to a greater degree than is the case at present.

The administration of the societies should be in the hands of their board of directors or councils, and similarly the important standing committees, in whose hands rests the conduct of affairs in the several branches of administration, should be committees of the board or council. Such being the case it is desirable that their appointment should, in the beginning, rest with the board itself, and that one member of each standing committee should retire each year, and the new president fill the vacancies; this would be a much more satisfactory arrangement than the plan followed by our Institute at present, under which the responsibility of appointing all committees, whether standing, special or temporary, rests alone with the president. The suggested plan of appointing the administration committees primarily by the board of council, the president filling the vacancies that occur each year, is not the one usually followed by our national societies; but even where all the appointments devolve upon the president alone, membership on the standing committees is limited as a rule to members of the board. The advantage of selecting the standing committees from the members on the board is evident; the committees are then not likely to follow a policy at variance with the wishes of the executive body, which would disturb harmonious relations between the society officials and continually raise questions of jurisdiction.

It is also desirable to avoid constant changes in the personnel of such important committees as the finance, library, and membership committees; provision should be made for standing committees of three or five members, with one member retiring each year, the vacancies to be filled by the incoming president. This plan secures continuity of policy, gives the committees the benefit of accumulated experience and relieves

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER.

During each fiscal year for the past five years.

Year	1901	1902	1903	1904	1905
Membership	1260	1549	2230	3027	3460
RECEIPTS PER MEMBER.					
Entrance fees	$0.61	$1.16	$1.59	$1.65	$0.83
Dues	8.61	10.06	9.01	9.33	9.30
Transactions, sales and advertising	1.03	1.54	1.79	2.11	1.70
Badges	.18	.26	.35	.39	.28
Interest	.12	.24	.21	.18	.21
	$10.55	$13.26	$12.95	$13.66	$12.32
DISBURSEMENTS PER MEMBER.					
Transactions	$2.83	$3.50	$4.67	$3.43	$3.77
Salaries	2.49	2.78	2.49	2.50	2.20
Meeting expenses	1.05	1.13	.87	1.16	.82
Rent	.94	.94	.65	.79	.75
Library, including rent and salaries	.55	1.85	1.38	1.39	.81
Postage	.46	.51	.69	.66	.66
Stationery and miscellaneous printing	.39	.53	.96	1.01	.70
General expense	.33	.59	.52	.45	.54
Badges	.16	.19	.27	.35	.25
Express	.15	.15	.15	.28	.22
Total	$9.35	$12.17	$12.95	$12.02	$10.72
Credit balance per member	1.20	1.09	....	1.64	1.60

the president of the responsibility of making a large number of appointments on entering his term of office. Such standing committees as the finance, membership, library, publication, and meetings committees, or the last two consolidated into one, are necessary for all societies, together with such other committees as the particular field covered by the work of the society may require. Outside of the standing committees required by the regular routine, it is desirable to avoid as far as practicable the appointment of special or temporary committees, and when the special work assigned to them has been performed, such committees should be discharged. Nothing is more subversive of effective and energetic administration than board meetings at which an interminable series of committees make "no report" or the chronic "report of progress."

In case it is considered inadvisable to appoint a separate committee on meetings, or on papers and meetings, and a committee on publications, or editing committee—a division of work which becomes necessary when monthly meetings are held with readings of papers and discussions, in addition to one or more annual meetings—it becomes necessary to define their respective responsibilities very clearly, placing upon the committee on meetings, or papers, the responsibility of accepting papers or communications for presentation at the meeting, and upon the publication, or editing committee alone, the responsibility for the publication of papers and discussions, in whole or in part, in the official transactions of the society.

It might be observed here that great care should be exercised so to conduct a society identified with a specific branch of engineering, that, as far as practicable, all of its divisions receive due consideration. In an institute of electrical engineering, the telegraph and telephone, electric traction and electric lighting, the central station and the isolated plant, transmission and distribution, design and construction, theory and practice, in fact all branches of electrical engineering, should receive consideration, and in soliciting papers for the series of meetings held during the year a wide range of subjects should be covered so as to interest and attract the largest circle of members.

We have already referred to the importance of conducting a national society on broad lines so that the members at large shall have a share in the benefits as well as the obligations of membership, whether they are located near the headquarters of the society or at a distance therefrom. It is manifest that when the monthly meetings, as well as the more important annual functions, are held at the headquarters of the society, the distant members feel that they are at a disadvantage, from which arises a tendency to form local clubs, or organizations and to secede from the parent society, or at least to lose interest in it. Our Institute has met this situation courageously, and through the initiative of Past-president Scott a series of local organizations was established, the number of which has been increased under succeeding administrations. These organizations have done much to keep up the interest in the Institute at distant points, and have undoubtedly induced desirable accessions to our membership and been an important stimulant to professional activity.

Our sister societies are facing the same problem and are watching the result of our undertaking—it can no longer be called an experiment—with great interest. But this scheme of local organizations, while undoubtedly successful, is developing new problems and new conditions, and requires the constant care and supervision of the central administration.

As the close of another administrative year draws near I have felt it incumbent upon me, in the fulfilment of a duty, to direct your attention to some of the questions that are before us, and to give expression to a few thoughts that have occurred to me as a result of several years of experience in connection with the administrative work of our own society and a study of the methods followed by our sister engineering societies.

The comparisons which have been presented and the suggestions which have been offered are not made in a spirit of criticism, nor am I unmindful of the splendid work accomplished by the framers of our present constitution, to whom the highest credit is due for that altogether excellent instrument. But our Institute is growing rapidly and with its expansion new problems are arising; its field of activity is constantly broadening, and it should be expected, therefore, that modifications in its organic law may from time to time become necessary.

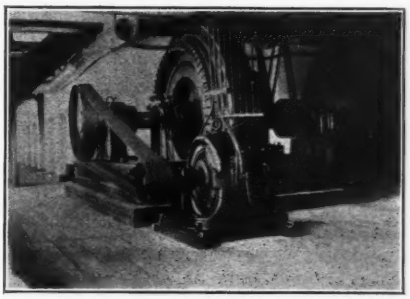
It is in the meeting and solving of new problems of society administration, such as I have referred to, that the youth and enthusiasm of our members is of the utmost advantage; we are less handicapped by precedent and tradition than some of our older sister societies, and we may therefore expect for the Institute of Electrical Engineers a glorious future, full of activity, initiative, and prosperity, and successful in the attainment of the highest professional standing, dignity, and usefulness.

UTILIZING A POWER STATION BASEMENT.

BY HOWARD S. KNOWLTON.

An interesting case of the expansion of a power plant beyond the limits of the generator room is shown in the accompanying photograph of a corner of the basement in the Indian Orchard station of the United Electric Light Company, Springfield, Mass. The Indian Orchard plant was one of the first hydroelectric installations to be operated in Massachusetts, and in the original layout the power-house design placed the water-wheels in the basement, driving the alternators, arc lighting and direct-current 500-volt generators on the floor above through the medium of line shafts, pulleys and belts. As the company's business increased, the generator room became well filled with apparatus so that at the present time the floor is occupied by three 330-kilowatt machines, and one 400-kilowatt generator, all being of the Stanley inductor type alternators, besides a number of arc and direct-current machines, two switchboards and a countershaft. About fifty feet of extension have been added to the generator room.

Recently a 600-kilowatt General Electric revolving field-type generator with a



BASEMENT OF INDIAN ORCHARD POWER STATION.

belted exciter was installed at the plant. In order to secure the higher efficiency and greater simplicity of direct-connection between the water-wheel and alternator the machine was set up in the basement, as shown, upon a brick foundation, an opening suitably railed being cut in the generator-room floor above to enable the attendant to watch the operation of the equipment. Considerable space has also been saved by the arrangement, which appears to work out very well in spite of the rather unusual disposition of the outfit in a basement corner. In the operation of revolving field alternators little attention is ordinarily required at the machines themselves, control being at the switchboard, and, in the case at hand, inspection of bearings and exciter brushes is easily made *via* a convenient stairway connecting the two floors. There would seem to be no good reason why in special cases generators should not be thus located, in view of the parallel practice of placing the auxiliaries of turbo-alternators in open basements beneath the engine room proper.

WIRE INSPECTION.

NEW RULES OF TESTING INSULATED WIRES.

In May of the present year a meeting was held at the headquarters of the National Board of Fire Underwriters, 32 Nassau street, New York, and an organization known as the "Wire Inspection Bureau" was formed. Ira W. Henry, vice-president of the Safety Insulated Wire and Cable Company, was elected president of the bureau, and J. C. Forsythe, chief inspector of the New York Board of Fire Underwriters, was elected treasurer, with a governing committee consisting of the following: W. H. Merrill, Jr., of the Underwriters' National Laboratories, of Chicago; C. M. Goddard, chief inspector of the New England Fire Underwriters' Association; Dr. Wm. M. Habirshaw, general manager of the India Rubber and Gutta Percha Insulating Company, and George A. Cragin, of the American Steel and Wire Company. Hugh T. Wreaks, of 32 Nassau street, New York, has been elected secretary by the bureau, which will pass on all rubber-insulated wire manufactured, and, it is announced, only such wire as the bureau approves will be allowed in the wiring of buildings.

A circular has been sent out by Secretary Wreaks which includes the following:

This bureau is to draw specifications for testing of rubber-insulated wire, manufactured under the rules of the National Board of Fire Underwriters, to decide on such tests, and when and how they are to be made. Also to appoint the necessary electrical inspectors, three being considered sufficient at present, which inspectors shall from time to time visit the testing laboratories of any factories making rubber-insulated wire and make, supervise and verify tests specified by the bureau.

The expense of these inspectors to be paid by fees collected from the manufacturing companies whose product is tested, each company paying its share in proportion to the amount of wire manufactured.

For the purpose of collecting the money to cover these expenses, stamps will be issued by the Wire Inspection Bureau and sold to the different manufacturers at a charge of one cent per hundred feet of wire tested. These stamps to be attached to the coils of tested wire by the manufacturers themselves, and to serve as a guarantee that wire so stamped has successfully withstood the tests specified by this bureau.

The majority of the rubber-covered wire manufacturers have recently agreed that on and after October 1, 1905, all National Code wire manufactured by their companies will be made up under the new specifications and duly tested, and will bear identification mark of the Wire Inspection Bureau. It is understood that a reasonable time will be allowed after this date for the disposal of code wire not bearing the stamp of approval of the Wire Inspection Bureau, on all such wire manufactured before October 1, 1905, and with this understanding the October list of electrical fittings will contain the names of all rubber-covered wire manufacturers agreeing to the tests of the Wire Inspection Bureau on their products, and to the use of identification stamps of Wire Inspection Bureau guaranteeing that these tests have been properly made.

The Wire Inspection Bureau will supply identification stamps to the rubber-covered wire manufacturers as may be required by the latter, and on receipt of their order for the same. These stamps will be for 250 feet, 500 feet and 1,000 feet coils, and will cost at the rate of one cent per 100 feet. No wire will be considered as having been tested which does not contain an identification stamp. (Stamps to be of linen paper and to be securely fastened to the shipping tags attached to wire coils.) Stamps will have serial numbers and on coils of less than above specified lengths where stamps specify more wire than coil contains, a credit for excess in stamp value can be obtained from the Wire Inspection Bureau on presentation of the facts in writing, giving size of wire, destination, number of feet and serial number of stamp used. All stamps to be cancelled by manufacturer when used, the date of manufacture of wire also being plainly shown. Wire Inspection Bureau specification giving factory tests which will be required on all wire having approved stamps will be ready in a few weeks, and will be furnished to manufacturers of National Electric Code wire.

Kindly read this letter over carefully, so that we may be sure that you understand the plan given, and in order that no apparent discrimination may be made against you next October through your not being fully advised of the scope and intent of the Wire Inspection Bureau.

Advise whether or not you decide to avail yourself of the services offered so that we may plan accordingly, and let us know as soon as possible how many identification stamps you will require and the proportionate number for 250-foot, 500-foot and 1,000-foot coils.

Mr. Henry, the president of the bureau, states to the ELECTRICAL REVIEW, that "the Wire Inspection Bureau was organized to improve the outfit of rubber insulations, especially so in places where it increases the fire risks. There have been so many fires attributed to defective insulation throughout the United States, that the principal companies making this material decided some active steps should be taken, whereby the new manufacturers entering the field for this line of goods should be kept up to a certain standard, which has been maintained for years by the older companies."

The ELECTRICAL REVIEW interviewed a number of the wire manufacturers interested and learned that they quite generally approved of this plan of testing the output.

Alfred F. Moore, of Philadelphia, though disclaiming any desire for publicity, said that his company would be very glad to cooperate with the Bureau of Laboratories in this effort to establish a higher plane for electrical wiring and considered their work worthy of commendation and support.

John C. Bridgeman, general manager of the Hazard Manufacturing Company, said: "there is nothing we have to say with respect to the circular letter of the Wire Inspection Bureau except to commend the methods they propose to use for securing wires of proper excellence and uniformity."

Fred J. Hall, assistant general manager of the India Rubber and Gutta Percha Insulating Company, in the absence of Dr. Habirshaw, said: "in common with all members of the Rubber-Covered Wire Manufacturers' Association we are heartily in favor of any practical method of inspecting and testing that has for its object the raising of the standard of insulation."

Henry A. Reed, secretary of the Bishop Gutta Percha Company, said: "this arrangement seems to be about as long a step in the right direction as is practical at present. We always favor anything reasonable which raises the standard of excellence and helps to guarantee that the purchaser gets what he pays for. Wires which stand the proposed tests must be fairly insulated and certainly free from present holes."

One large company expressed itself as follows: "We believe that this action, which is somewhat comparable with the government inspection which obtains in Germany, will naturally tend to improve and maintain the quality of the product, and in such condition is of definite value to the interested, particularly where electrical construction is affected."

Several of the wire manufacturers were interviewed but did not desire to be quoted at the present time.

The new electro-technical laboratories at Liverpool University, were opened by Sir Joseph W. Swan, on Saturday July 8.

RAPID TRANSIT IN GREAT CITIES.[1]

BY WILLIAM BARCLAY PARSONS.

One of the outcomes of modern civilization has been to collect populations into large centres, and with such segregation there has arisen a series of problems of which our forefathers took no heed at all or at most but little thought. A large city entails the supply of its people with light, heat, power, food, water, drainage, housing, pavements, and means of intercommunication. All of these problems, except the last, increase in difficulty and importance, substantially in direct ratio to the size of population. With transportation, however, the increase is as the square or even as the cube. Double the size of a city and you have not only twice as many people to carry, but you must carry them twice as far; and as the minute and not the yard is usually the proper unit of distance, doubling the distance means a doubling of speed. In New York, with its population of 3,750,000, there are being carried now on the surface, elevated and subway systems paying passengers, exclusive of so-called transfers, 1,200,000,000 per annum, a number very much greater than the number of passengers on all the steam railroads of both the American continents from the Atlantic to the Pacific, and from that most northern of all railroads, the Wild Goose Railway, near Nome, Alaska, within the Arctic Circle, to the most southern one in South America, the State Trunk Line, of Chili. London with its population of over 6,000,000, but with inferior intra-urban railway facilities, carries about the same number as New York; while Paris, Berlin, Hamburg, Boston, Chicago and St. Louis are fast following in the leaders' tracks. Such figures need no further comment or explanation to indicate the dimensions of the problems of transit in great cities, and the difficulty of properly meeting the continual demand for increase in facilities as cities grow.

The elevated railroad is essentially an American design, having been suggested first by Colonel Stevens, of Hoboken, N. J., as early as 1830, only five years after the first steam passenger line was opened in England, and two years after a similar event occurred in America. It was not, however, for forty years that the suggestion was given practical application, and then to avoid in New York the difficulties experienced in London of working an underground line by steam locomotives. This form of construction was extended in New York, or what is now the boroughs of Manhattan and The Bronx of that city, during the following ten years, resulting in the present elevated system, with a length of thirty-eight miles of route.

We will now take up the other form of rapid transit railroad, the one beneath the surface. The first line of this character to be constructed was in London in 1865, but there the results of operating by steam locomotives were so disagreeable that no other similar move was made until another kind of motive power was possible. The next contemplated power was the cable, and the line built to receive it was the City & South London, the first of the so-called "tubes." But before it was completed in 1894, the practical feasibility of electricity as power on a large scale for transportation purposes had been amply demonstrated, so that an electrical and not a cable plant was installed. The attending success showed that it had become possible to use, with comfort and cleanliness, the great subsurface for transit purposes, a space hitherto considered of value only as a place wherein to bury sewers, water and gas mains in haphazard and disordered confusion. It is especially this use of the ground beneath our streets to which I desire particularly to direct attention.

The construction of the City & South London, with its electric installation, established a new order of things in two ways. First, it showed the feasibility of the new form of power application. Second, it showed the feasibility of tube construction. From this success a rapid development of underground construction began, and railroads of this character have since been built in Buda Pesth, Paris, Berlin and Glasgow in Europe, and in Boston and New York, with one now building in Philadelphia. Constructively speaking, these railroads are of two quite different types, the very deep, and the very shallow. The former is represented by the tubular construction. Although this form of construction was first put to a practical completion in England, it is really of American origin, a short sample line having been constructed some forty years ago in New York by Mr. A. E. Beach, which sample still exists. In England it was developed by the late Mr. Greathead, in the city of South London, and afterward by other engineers on three other lines, with two more now building.

In the matter of operation, substantially the same general principles apply to all rapid transit railroads, where the problem is how to move the greatest number of people over a given distance with the minimum of expense. Unless the mono-rail system possesses sufficient advantages to overcome their disadvantages and compel their adoption, nothing better has yet appeared than the ordinary railroad track of standard gauge. This track should be of the heaviest type regardless of the light rolling stock, especially if high speed is to be attempted. Curves should be carefully spiralled, and superelevation given, not according to a fixed rule, but varying with each curve and adopted to the speed that trains will make at that particular point. With cars you will find a field wide open for fertility in design, and where there is a contest between advocates of end doors *versus* side doors. Except for the all-metal cars recently introduced in the New York subway to eliminate fire risk, there is not much of striking novelty advanced, and nothing that has any great bearing on economy of operation except the facility to unload and load passengers. Every second's delay at a station repeated by every train, say, four times per mile, and at train intervals of one minute, means an increase in the number of trains required to maintain a given service. In spite of many manifest advantages of side doors, the tendency of practice is toward the type of American car with end doors, such cars having been adopted on the several lines in London and on the recently constructed combined subway and elevated in Berlin.

In the matter of motive power, the greatest advance has been made, and there probably remains the greatest possibility for future improvement. The steam locomotive, quite apart from the objectionable features of smoke, has already been permanently relegated to the scrap heap. For the moment, electricity is the only form of power that satisfies the requirements of the problem, and it will so continue until disturbed by some other. In order to maintain speed with frequent stops, the motors must have a high power of acceleration. In this respect the steam locomotive is sadly deficient. The best rate that the engines on the New York elevated could reach on loaded trains was 0.6 mile per hour per second, while the electric motors can give in actual practice 1.5 miles per hour per second. That is, in the first case twenty seconds were required to develop a speed of twelve miles, while only eight suffice in the latter case. Furthermore, the electric motors can be distributed throughout the train and so

[1] Abstracted from an address delivered at Purdue University.

avoid heavy concentration. On an express train of eight cars in the New York subway there are five motor cars, with two axles each, equipped with 200-horse-power motors, so that the total power per train is 2,000 horse-power. This is the nominal rating, but the actual power, during a possible period of overload when accelerating, is at least twenty-five per cent greater. To equal this in steam locomotive practice would call for two locomotives of the heaviest passenger type. These motors thus distributed through the train are, of course, under simultaneous control by the motorman at the head of the train, or in case of emergency at any other point.

Power for these motors is produced in large central plants. The largest of such plants as yet constructed is that of the New York subway, where the main units have an output capacity of 10,000 horse-power, and where the total capacity of the whole plant, including subsidiary engines, is 135,000 horse-power. The current as produced is of the alternating variety, and is generated at a pressure of 11,000 volts. As such it is carried to nine substations, averaging about two and one-half miles apart, where it is transformed to direct current and reduced in voltage to about 600 and thus fed to the line. The total weight of copper in the transmission cables on twenty-one miles of road in operation is over 6,500 tons, which would have been much increased if direct current alone had been used, and could have been reduced if alternating current could have been used throughout. The advance in design of the structural parts of elevated railroads or of subways with reenforced concrete walls has substantially exhausted any great possibilities in economy of design. This, however, is not true in respect to power and its application. The cost of power per car-mile by steam operation on the New York elevated was 12.18 cents; by electricity, under methods employed to-day, it is 9.47 cents, a reduction of nearly twenty per cent, while at the same time the average speed through quicker acceleration has been raised from thirteen to fifteen miles per hour. It is possible that, by means of higher steam pressure, turbines in place of reciprocating engines, higher voltage for transmission, the use of alternating-current motors working at 3,000 volts, this cost can be still further reduced without imagining any radical departure from existing standards in practice.

In regard to operation, all but one of the rapid transit systems so far built are an extension of the principles of the surface service, that is, cars in units or in trains stopping at all stations. In New York, partially on the elevated lines, but more particularly in the new subway, the principle has been established in differentiating between the short and long-distance traveler, and in giving to the latter a special train service on separate tracks, stopping at stations about one and one-half miles apart instead of one-quarter mile. This marks to date the maximum development in rapid transit facilities, a development, however, that will probably soon be repeated elsewhere, and will eventually be exceeded in New York by an express service with even higher speed, that is, with fewer stops.

Let us now turn from the engineering consideration of the question and briefly take up the legal aspect. The first established lines of transit were the omnibuses, which differed so little from other vehicles that their use of the public highway without special charge or tax was considered an obviously proper use. When the omnibus gave way to the horse car, it was held that such use was still proper, as the horse car was but an omnibus running on fixed lines, and the right to use public streets without payment was granted by the public authorities to street railway corporations. To-day, in practically every city in the United States, we find electric cars, the successors in turn of the horse cars and of their privileges, using public streets without franchise payment or at most with small ones. Such a result was not foreseen when omnibuses were first started. Now our economists are agitating a reversal of policy and demanding either that a proper payment shall be made for the right of way or that the title shall remain in the municipality, and that the right to run shall not be under a fixed grant but under a lease.

The modern rapid transit railroad is an exceedingly costly structure. The tubular railroads for two tracks, including stations and equipment, are costing in London about £800,000, say $4,000,000 per mile. Portions of the New York subway, with four tracks but exclusive of equipment, cost $5,000,000 per mile, and the total cost of the structure for twenty-four miles, of which six miles are elevated and therefore comparatively much less expensive than the subway, cost $2,000,000 per mile, and the equipment will add $750,000 per mile in addition. A large modern urban railroad represents, therefore, a great aggregation of capital and the forming of a corporation with necessarily great power, both financial, social and political. In this respect some people see such danger that they are demanding that all such railroads should belong to the municipality in which they are located and be operated by it. In England, where this movement has progressed further than here, many of the surface railways have been bought by the public authorities. As to the success of the movement there are widely different opinions. The experiment has not reached a definite conclusion. While awaiting the outcome no municipality has as yet undertaken to own and operate a rapid transit railway, although such ownership, without operation, has been retained in three cases.

The existing lines maintain their corporate existence in two ways, either by proprietary right, or by lease from the municipality. As examples of the former, are the London railways and the elevated roads in New York, where special privileges have been conferred by law on the corporations, and they own, in their own right, the lines they have built. As examples of the latter, are the railways in Paris, Boston and New York. In each of these cases the subways were built by the city itself, out of public funds, and then leased to a private company to be operated by it. In Paris the railroads are first built by the city at its own cost and by its selected contractors, and then turned over, as each piece is completed, to the same lessor company to be operated by it, the company paying to the city of Paris one-third of the gross receipts as rental. If this sum exceeds the interest on the cost, the city of Paris is the gainer, otherwise a loser. The authorities, therefore, see to it that the work is economically conducted to keep down the interest charges, and that routes are selected which will return heavy traffic receipts. So far the results have shown a profit to the city of Paris.

In Boston the system of subways was constructed admittedly to accommodate the cars and trains of the company owning the surface and elevated lines. After the work of construction was completed, under the direction of an honest and capable board, it was leased to the railroad company at a rental of four and one-half per cent on the actual cost. As Boston can borrow money at a considerably lower rate, this return is sufficient to repay interest and allow for depreciation and a small profit, besides developing the city.

In New York the law provides that a contract shall be offered to public bidding,

and that the contractor shall be paid by the city the amount bid by him for construction, and that he shall then operate the railroad for a period of years, paying as rental such interest on the cost as the city pays, and in addition one per cent as a sinking fund. Although differing in details, the plans of Paris, Boston and New York have in common the general principles of ownership by the municipality, and thereby the retaining of control of the public streets. The terms fixed by these three cities are moderate, being at most little more than interest on cost, and as such tend to invite capital to embark in the building of these railroads. Such development is the prime object, and not municipal profit. In following the examples already set, other communities will do well to pattern closely and not impose burdens that will hinder rather than assist.

In studying the problem for the building of a new line or the reconstruction or extension of an old one, the engineer should be sure he understands all phases of the question. While it is his business to supply the public with the facilities that the public desire, and not what he thinks they should desire, nevertheless he must be sure that there is sound and permanent logic in public demand. The traffic routes should be analyzed to determine the trend of travel and reasons for it. Frequently arguments are advanced that railroads should not be built along congested streets, because they tend to increase congestion, but instead they should be built along other and less frequented streets so as to draw travel away from the congested routes. Travel is usually concentrated along certain routes for well-established reasons, and frequently in spite of lack of transportation facilities. In this case it is idle to talk of drawing travel away. People that have become set in certain ways are hard to change, and a line built off a line of travel is of little public benefit and is doomed to failure or to a long wait for business to originate before attaining success.

People also wish to be carried quickly. As our cities grow and distances increase, this question of speed becomes more and more important, as people measure the distance by minutes occupied in travel. Railroads for rapid transit should, therefore, so far as possible, be on straight lines, and if one straight line can not reach all the desired points, then other railroads must be built as soon as business warrants. The mistake should not be made of sacrificing the best individual results in the attempt to partially satisfy many. These were the errors in the location of the first underground railroads in London, where the attempt was made to avoid congested routes and give a circuitous location.

The general type of the railroad to be built will also require careful consideration, whether elevated or subway, whether shallow or deep. Here one must be careful not to draw hasty conclusions that, because a certain type or method of construction has succeeded in one place, it will succeed equally elsewhere. This mistake was made in Brooklyn and Chicago after the initial success of the elevated railroad in New York. Then when once a type and general design have been adopted as best suited for the locality under consideration, the engineer must be on his guard not to be so closely wedded to his design as to fail to recognize when to vary it or even when to depart entirely. The New York subway is called an example of shallow construction, that is, as close to the surface of the street as possible, and so it is, for such was the motive of the design to be followed as much as practicable. Yet of the 24.7 miles of which it is composed 5.7 miles are elevated, 1.4 miles are in iron-lined tubes, 3.4 miles in deep tunnel, 1.2 miles in arched construction, and only 13 miles, or but little more than one-half of the whole, are of typical shallow construction, with a flat roof of steel and concrete construction. These changes were made for local topographical reasons, whereby better operating results were obtained.

In laying out rapid transit lines, it is found that people will not walk far to reach even a superior means of transportation, but are inclined to take the first at hand. For this reason one such road will not serve a very wide belt of territory, and the danger of disadvantageous parallel competition does not exist in anything like the same degree as with ordinary railroads operating in the same territory. New facilities of this character create their own traffic. The chief question arising is whether any particular route possesses in itself sufficient possibilities to justify the expensive construction. As parallel competition is not to be much feared, so new lines, even of an opposition corporation, should always be so constructed as to be capable of physical connection to permit through running. The whole tendency of American experience is toward consolidation of a city's transit lines. As a matter of fact, the public are better served when all lines are thus gathered together as a monopoly, and thus give the people the benefit of through running or of transfer.

In this respect the city of Paris has set a wise precedent in creating a single private corporation to which are to be awarded all the rapid transit lines as fast as built. The municipal authorities there have thus boldly prevented any so-called competition, and have even organized a private monopoly. On the other hand, they have secured the certainty of operation of lines which, independent, would not pay to operate, thus affording means of rapid travel to all parts of the city, and have secured for the inhabitants the privilege of making any journey in any direction of even the greatest distance for a single fare.

London, on the other hand, is an illustration of the opposite plan. Of the six tube railroads now built or building, there are five different sizes calling for entirely different standards of equipment; so that, if ever these lines should come together under a single management, uniformity of management and physical connection are out of the question. Even with the surface lines, some of which are owned and operated by the London County Council, and others by private corporations, antagonism is so great that physical connections are prohibited, and necessary extensions of private lines prevented, thus making passengers change cars and actually depriving the public of much needed facilities. In these two great cities we see, on one hand, monopoly working smoothly for its own advantage and the public benefit, and on the other competition existing to the point of general injury, public as well as private. So acute have become the London conditions that the British government has had in existence for two years a royal commission studying the problem, with a view of proposing some remedial measures.

In judging of the value of traffic routes, two chief considerations must be kept in mind. First, mere density of population does not of itself signify great traffic returns. A certain portion of the population of great cities, and usually that which is densest, is not migratory, but being clustered around its work has little cause to go to other parts of the city. On the other hand, there are neighborhoods where the population is much more sparse, but where the residents leave their homes for business, shopping, visiting, school and entertainment. One must differentiate therefore between traveling and stationary population. This is well illustrated in

New York, where one of the elevated lines traverses the celebrated tenement-house district, where more people live per acre than in any other city of the world. The traffic returns are very low. Other portions of the line traversing districts where the population is not one-tenth of the former show receipts several fold greater. Second, special points of occasional crowding are not so productive of traffic as they would seem to be. Recreation grounds and parks used occasionally or on certain days or seasons are illustrations, and even terminal stations of great railroads. To again quote from New York experience, when it is remembered that the Manhattan elevated and subway systems alone, on but a little over fifty miles of road, carry two-thirds as many passengers as do the steam railroads of the United States on over 200,000 miles, it needs no demonstration to show that the number of passengers interchanged with the Grand Central Station, the terminus not only of the New York Central system, but of the New England railroads as well, does not constitute a large percentage. Even in London, where the facilities are inferior to an American city, the board of engineers in their report advising the royal commission above referred to, show that one trolley terminus where the lines, through opposition, are compelled to stop short of ultimate destination, discharges and receives more passengers than are similarly handled at six large railroad passenger stations combined. A street passing through a commercial or shopping district, with places of entertainment in the neighborhood, is a much more desirable district to reach from the point of financial return, and more necessary from the point of view of public convenience, than the greatest railroad terminus or most popular ball ground.

Evening Courses in Transportation.

The Polytechnic Institute, of Brooklyn, announces a series of evening courses for the year 1905-1906, in transportation, steam engineering, water supply, structural design, draughting, mathematics, chemistry and electricity, with laboratory practice and testing. These lectures are designed to be concisely practical in their treatment of the subjects. Problems, illustrating the subject, will be announced by the lecturers and encouragement given to those desiring to solve them to present reports in professional form. Those wishing to enter as candidates for a degree will receive credit, upon the requirements for the degree, for the reports so filed, upon previous arrangement to that end with the president and the professor-in-charge. The fee for the course on transportation is $15. The fees for the other courses are at the rate of forty cents an hour for 100 hours or under, thirty-five cents an hour for 100 to 200 hours, and thirty cents an hour for 200 or more hours.

Lectures, courses and laboratory practice are given at the Polytechnic, 85 Livingston street, in sessions of two hours, commencing at 7.30 in the evening.

The following subjects and dates have been decided upon:

October 10—"How to Route the Line and Determine the Most Suitable Service," Professor H. A. Lardner.

October 24—"Legal Points as to Franchises, Organization, Eminent Domain and Liability," R. Burnham Moffat, Esq., member of the New York bar.

November 7—"Problems in the Electrification of Steam Roads," Professor W. D. Young.

November 14—"The Compound Locomotive; Its Design and Development," Professor L. H. Fry.

November 28—"The Future Compound Locomotive," Professor L. H. Fry.

December 12—"The Hauling Capacity of the Locomotive," Professor G. B. Henderson.

December 20—"The Fuel and Water Consumption of the Locomotive," Professor G. B. Henderson.

January 9—"The Strematograph and Its Revelations," Professor P. H. Dudley.

January 16—"Where to Locate the Power-House," Professor W. B. Barstow.

January 23—"Fixed Signals," Professor B. B. Adams.

February 6—"Block Signals," Professor B. B. Adams.

February 13—"How to Design the Power-House," Professor H. G. Stott.

February 20—"The Gas Engines for Central Station Service," Professor R. D. Mershon.

February 27—"How to Organize the Operating Force of the Power-House," Professor H. G. Stott.

March 6—"The Steam Turbine for Central Station Service, Its Sensibility as Compared with the Gas Engine," Professor R. D. Mershon.

March 20—"Problems in Train Despatching," Professor C. H. Ketchum.

April 3—"Maintenance of Way Problems," Professor G. H. Paine.

April 17—"The Scandinavian Railroads under Government Ownership," Professor M. C. Ihlseng.

April 24—"How to Operate the Complete Plant," Professor J. F. Calderwood.

Twelve lectures, and exercises in engine testing, on the steam engine and other motors, by Professor Ihlseng. These lectures will treat of the expansion of steam, air, gas and oil in engines, turbines, locomotives, compressors and ice machines. Indicator cards will be discussed, and their use in correcting defects of operation, valve setting, etc. All the types of engines mentioned will be tested. Typewritten notes of each lecture will be distributed in advance of the exercise. Friday evenings, 7.30 to 9.30, commencing October 6.

Fifteen lectures, with problems, on structural design, by Professor Ihlseng. The fundamental principles of stress and strain will be discussed, and the simple formulæ, diagrams and tables used in practice will be employed in the calculation of the strength and dimensions of parts of simple bridges, boilers, cranes, journals, gears, belting, shafting, flywheels, etc., and in the parts of frames, machines, trusses and details of fireproof and slow-burning mill buildings. Problems and examples will be taken in class and their complete solution will be presented to each attendant of the course. Additional examples, for individual work, will be given as desired. Friday evenings, 7.30 to 9.30, commencing January 19.

Fifteen lectures and a series of laboratory exercises on hydraulic engineering. In addition to taking up the theory of the flow of water through pipes, laboratory work will be introduced to illustrate the principles and to test pumps, waterwheels, weirs, nozzles, orifices.

Fifteen lectures on train movement, by Professor Mailloux. The lectures will treat of the complete subject of train movement from the physical, mathematical and engineering standpoints. Wednesdays at 5 P. M.; commencing November 29.

The practical work in connection with the above courses will include, besides the college laboratories, courtesies offered by outside concerns for the testing of locomotives, train movements, car resistance, track irregularities, etc. Subscribers to the course of lectures on transportation will have an opportunity to take part in a series of tests on the operation and control of surface trolley cars and elevated third-rail trains. These tests will be carried on under the direction of Mr. Sydney W. Ashe.

THE HANDLING OF ELECTRICAL INSTRUMENTS IN RELATION TO THEIR ACCURACY.[1]

BY H. B. TAYLOR.

In using electrical measuring instruments and in setting them up for making a test, there are certain points to be considered which are likely to be overlooked by men who have not frequent occasion to use them. This is especially true where a number of instruments are to be used on one test. In the effort to put all the instruments in places where they can be conveniently read and at the same time have other apparatus within easy reach, there are many chances of placing some of the instruments in locations where their calibration will be temporarily affected by their influence upon each other or by the effect of some other piece of apparatus or part of the conducting circuit.

THE STRAY MAGNETIC FIELD.

A knowledge of the principle upon which an instrument operates, the location of its winding and of its magnet, if any, should enable the person using it to judge whether a particular location is suitable. Some instruments are quite susceptible to external influences, while with others, scarcely any attention need be paid to the location of stray magnetic fields. So many kinds of instruments are in use that it would not be possible in a short article to discuss the different types, or the various capacities of those of any particular type, but it may be said in general that there are more opportunities for error in measuring heavy currents than in measuring small ones. In direct-current work there may be disturbing influences entirely apart from the apparatus in use on the test; such, for instance, as the field of a motor or a generator or a nearby bus-bar carrying heavy currents. Instruments containing permanent magnets will, if placed too close together, influence each other. The natural tendency is to place them in almost the worst possible position; that is, side by side. A space of from two to three feet may be taken as a safe distance to allow between direct-current meters of the ordinary portable type. When space is very limited, two instruments can often be brought closer together without causing trouble, by placing one of them with its scale inverted with respect to the other, so that the neutral parts of the magnets are nearest to each other and the pole-pieces as far apart as possible. For the most accurate results even the earth's magnetic field must be taken into account, the maximum possible variation in reading from this cause being usually a little more than one-tenth of one per cent.

With the exception of the astatically wound instruments which have recently been introduced in portable form, electromagnetic instruments designed for use on both alternating and direct currents, when used on direct current must be read with the current first in one direction and then in the other. The average between the direct and reverse readings gives the true reading if the scale is uniform. If all external magnetic fields acting upon the instrument are independent of the current in the circuit the reversal can be made at any convenient point, but if there is a probable influence from the conductors or apparatus in circuit, it is best to make the reversal at the terminals of the instrument in order to correct for all stray fields at once.

Alternating and direct-current ammeters and wattmeters made for heavy currents are likely to have only a turn or two in the coils carrying the main currents. It is then a matter of importance in connecting them, to bring the leads to them in such a way that they do not form a loop which can set up a magnetic field aiding or opposing that of the instrument winding. The best way of doing this is to keep them very close, preferably twisted together for some distance away from the meter. With alternating currents there is less chance of disturbing influences apart from the apparatus in the circuit than with direct currents, because only alternating fields at the frequency of the circuit and having a fairly constant phase relation with it can affect the instruments. This practically limits the stray field influence to that of the instruments and other apparatus in the circuit upon each other. It will be remembered, however, that alternating and direct-current instruments are more susceptible to influence from conductors than are direct-current instruments.

The foregoing remarks do not apply to induction instruments as the principle upon which they are made is such that a stray field could scarcely enter in a way that would affect them. Neither do they apply to electrostatic and hot-wire instruments. There are so many things which tend to prevent accurate work with the latter two classes of instruments that they are little used in ordinary testing. Their most valuable property is that the voltmeters are independent of the frequency. Electrostatic voltmeters have the additional feature, which is valuable in certain kinds of work, that the energy required to operate them need not be considered.

CORRECTION FOR ENERGY LOSSES IN THE INSTRUMENT ITSELF.

In dealing with small currents, five amperes or less, it is often necessary to take into consideration the energy required to operate the instruments themselves. Voltmeters and the shunt circuits of wattmeters, when connected on the load side of ammeters or the series coils of wattmeters, may take enough current to make a decided difference in the results if not corrected for. Some indicating wattmeters are designed to correct for their own shunt current when it passes through the series coil, but there are usually voltmeters or other wattmeters in the circuit which still have to be allowed for. If the voltage between the terminals of the voltmeter will not be affected by the voltmeter current it is sometimes practicable to open the voltmeter circuit after reading the voltmeter but before reading the other instruments. This practice of disconnecting the voltmeter is itself sometimes a source of error. As an example: suppose the voltages between the sections of a small impedance coil at a certain current are being measured while the current is passing through the whole coil. If the ammeter is read while the voltmeter is in circuit, it is obviously necessary to correct its reading for the portion of the current which passed through the voltmeter. If the voltmeter is read and then disconnected the reading observed can not be taken as that due to the current indicated immediately afterward by the ammeter because the voltage between the points where the voltmeter was connected will rise as soon as it is disconnected, due to the fact that the coil is no longer shunted by the voltmeter winding.

The accuracy of a great many tests will not be appreciably affected if the instrument losses are neglected in calculating the results, as the degree of accuracy does not make it worth while to correct for them. It is then desirable to connect the instruments for a minimum error from that source. When the series instruments are of low resistance and the voltage under measurement is so high that the drop of voltage in the instruments is comparatively small, it is best to make all shunt connections on the line side of the series instruments, as the error due to including the drop of voltage in the series instruments is likely to be lower than that which would result from placing the shunt

[1] Reprinted from the *Electric Journal*, Pittsburg. Slightly condensed.

instruments on the load side and thus including them with the load being measured.

If the voltage is low compared with normal working voltage of the shunt instruments, or the series instruments are loaded sufficiently to give a considerable drop of voltage between their terminals the connection of the shunt instruments to the load side may be the better plan. It does not usually require much extra time to check a reading with both methods of connection. All that is necessary is to change the lead to one side of the shunt instruments from the line to the load side of the series instruments or *vice versa*.

While, as stated above, there are more opportunities for inaccuracy in measuring large alternating currents than in measuring small ones, the instruments most likely to lead to error in measuring alternating-current voltages are the low-reading ones. Direct-current voltmeters and wattmeters in all ranges from 0.5 volt up are equally accurate. Voltmeters and wattmeters for use on circuits at 100 volts or more, alternating current, are generally reliable throughout a wide range of temperature and frequency. Those wound for lower voltages, particularly those for measuring electromotive forces in the neighborhood of ten volts, have always a relatively large temperature coefficient and the proportion of inductive to non-inductive resistance is higher. On account of this higher temperature coefficient it is important to take careful note of the temperature of low-voltage alternating-current voltmeters and wattmeters. When accuracy is important or the frequency unusually high, it is also necessary to correct the readings for the inductance of the winding. If the instrument is zero-reading the inductance will be constant for all loads and can be corrected for by means of a simple factor which will be constant for any given frequency. Direct-reading instruments in which the relative position of the fixed and movable elements changes at each change in the reading, have a different inductance at each reading. Their readings can be corrected with a fair degree of accuracy by assuming that the factor suitable for the half-scale position is constant for all readings.

The correction factor is sometimes given by the instrument maker. If not, it can be found by measuring the resistance and inductance of the winding and calculating the impedance for the frequency at which it is to be used. The true volts will be higher than the scale reading in the same proportion as the impedance is higher than the ohmic resistance. The majority of people who use portable meters do not have facilities for measuring inductance accurately, but this particular correction is so small as to be of little interest outside the laboratory, anyway. At the highest commercial frequencies the lowest reading alternating-current voltmeters require an inductance correction in the neighborhood of two per cent. A fifteen-volt voltmeter on a sixty-cycle circuit reads within 0.1 per cent of what it would read at the same voltage on direct current.

Mutual induction between the shunt and series coils of wattmeters is often a more important item than the self-induction of the shunt coil in causing errors in measurements at high frequencies or low power-factors. A rough check showing whether the mutual inductance in a wattmeter is excessive can be made by short-circuiting the series coil while the shunt is connected to the line at normal voltage at a frequency of sixty cycles or higher. If the movable element is freely pivoted and does not show any deflection the mutual induction between the coils is probably not high enough to cause any serious error.

PRECAUTIONS.

Modern electrical instruments will stand a great deal of service under severe conditions if proper care and judgment are exercised in handling them. They will even stand a certain amount of ill treatment that would seldom be met with except through carelessness. Experience shows, nevertheless, that there are few instruments in daily service which do not occasionally meet with more or less damage. In nearly all instances where a meter is overheated, broken, or otherwise thrown out of adjustment, the cause of trouble is quite apparent as soon as the damage is done, and the person responsible finds that he knew beforehand what would happen under the conditions which caused the trouble, but had failed to notice that these conditions existed. When a man connects an ammeter in shunt across a 500-volt circuit it is seldom because he thought that the proper way, but because he thought he had a resistance, or something having the same effect, in series. To have mentioned to him a week previously that ammeters should not be connected that way would probably not have prevented the accident. It is therefore not easy to compile a useful list of connections to be avoided.

On paper, the causes which produce ninety-nine per cent of the damage to instruments look so simple that few people who are at all familiar with electrical work would gain anything by reading them. Usually the trouble is caused by an overload of one kind or another. Wattmeters and low-reading voltmeters suffer oftener than other instruments from the kind of mistakes which are least likely to be detected in an inspection of the connections. A wattmeter operating at low voltage, say one-tenth to one-fifth of its normal voltage, will have its series coil greatly overloaded before it shows a deflection as high as half-scale. Or, if the current in the series coil is small the voltage across the shunt terminals might be raised so high that the shunt winding would burn out before the scale reading would indicate anything approaching an overload.

A voltmeter used in measuring the voltage across a highly inductive circuit, for instance, a direct-current voltmeter used in connection with an ammeter to measure the resistance of a transformer winding may be damaged by the field discharge if the circuit is suddenly broken outside of the voltmeter connections. In a somewhat similar way, instruments connected to the armature of a machine may be injured if the field current is suddenly broken. These are examples of momentary overloads which are not likely to burn out the winding but may bend the index or strain other movable parts. When a wattmeter shunt or voltmeter is connected across part of a circuit in which the line voltage is higher than the maximum range of the instrument, it is important that the part of the circuit between the instrument terminals shall not be broken while the instrument is connected. To do so would, in most cases, practically place the total line voltage across the meter. Disconnecting a series instrument while the shunt instruments are connected to the line side of it is a common cause of such accidents.

There is no good way of protecting voltmeters against sudden great overloads; the probability of injury can be reduced by keeping them disconnected at all times when readings are not being taken. Series instruments can be protected to some extent by having switches arranged to short-circuit them, the switch being opened only when a reading is to be taken. Fuses or circuit-breakers can be used to prevent the winding from being actually burned out, but they can not prevent the mechanical shock to moving parts due to sudden overloads. With series instruments having considerable resistance, the short-cir-

cuiting switch may not be applicable, especially if the voltage of the circuit is low. If the current were adjusted with the instrument in circuit, the short-circuiting of its resistance might cause an undesirable rise of current.

A very common practice which is detrimental to the pivot of instruments which have carrying-cases separate from the meters themselves, is the habit of standing the box with its opening at the top and dropping the meter into it instead of laying the box on its side and sliding the meter in.

ZERO ERRORS.

The question of zero errors and how to correct for them is of frequent occurrence. Sooner or later the index of nearly every meter fails to indicate zero at zero load. The exact reason is not always apparent. It may be known that the error appeared immediately after a short-circuit or after the meter was dropped to the floor, but that information would not show whether the spring had changed its shape, the index bent, some part of the movement slipped or one or more of a number of other possible disarrangements had happened. A rather common source of error at zero as well as at other readings is a fine springy piece of lint resting on a fixed part and pressing lightly against the movable part in such a way as not to cause friction, but acting as a little additional spring.

To add, algebraically, the zero error to the observed reading seldom gives exactly correct results. Sometimes it introduces a greater error than if no correction had been attempted.

In many instances where the zero reading has changed quite appreciably, there is no difference in the calibration of the instrument at points above one-fourth scale reading. There rarely is a uniform change throughout the scale. As a general thing, it is safer to rest the zero reading or to assume that the zero error has not changed the calibration at the upper part of the scale than to attempt to correct for it. Indiscriminate resetting of the zero reading by means of the usual spring-adjustment is not to be recommended. If the error has been caused by bending the index it is better to bend it back again even though the displacement was slight. If this is not done the relative positions of the fixed and movable elements of the meter will not be the same for any given reading as they were when it was first calibrated. The effect of this is most noticeable in those instruments which are direct-reading and do not have uniform scale. When recalibrated, the readings on the scale will be found to follow no uniform law. The reading at one point may be too high and those a short distance on either side of it too low. Such irregularities make the correction of a set of instrument readings more laborious than it would be if all readings were a certain percentage high or low.

The American Street Railway Association.

The twenty-fourth annual meeting of the American Street Railway Association will be held in the South Building, Philadelphia Museum, Thirty-fourth street, Philadelphia, Pa., September 25 to 30, 1905. The American Railway Mechanical and Electrical Association and the Claim Agents' Association will meet Monday and Tuesday, September 25 and 26; American Street Railway Association, Wednesday and Thursday, September 27 and 28; the Accountants' Association, Thursday, Friday and Saturday, September 28, 29 and 30.

The report of the "reorganization committee" will be presented and acted upon, a new constitution and by-laws have been prepared and it is the desire of the executive committee that as many of the members as possible be present to consider them. Papers will be presented on gas and other engines, organization and single-phase systems for street railways. The Manufacturers' Association will have a large exhibition of appliances. The exhibition hall has over 60,000 square feet of space.

The passenger associations have granted rates of a fare and one-third on the certificate plan. A certificate must be secured from the ticket agent when purchasing ticket and left with the clerk when registering.

The headquarters will be at the Bellevue-Stratford Hotel.

Plan for Magnetic Survey.

The magnetic survey of the North Pacific ocean is to be begun at once by the Department of International Research in Terrestrial Magnetism of the Carnegie Institution at Washington.

A wooden sailing vessel, the brig Galilee, has been fitted for the purposes of the expedition at this port, and it is expected that she will sail the latter part of the week on her first season's work.

The director of the work is Dr. L. A. Bauer, who likewise is in charge of the magnetic work of the United States Coast and Geodetic Survey. The scientific leader and commander of the Galilee will be J. F. Pratt of the United States Coast and Geodetic Survey. The members of the scientific corps are Dr. J. Hobart Egbert, magnetic observer, surgeon, and naturalist; J. P. Ault, magnetic observer, and V. W. Whitney, magnetic observer and watch officer.

The details of this survey were published in the ELECTRICAL REVIEW, February 4, 1905, in an article by Dr. L. A. Bauer, director.

Alexander M. Bell Dead.

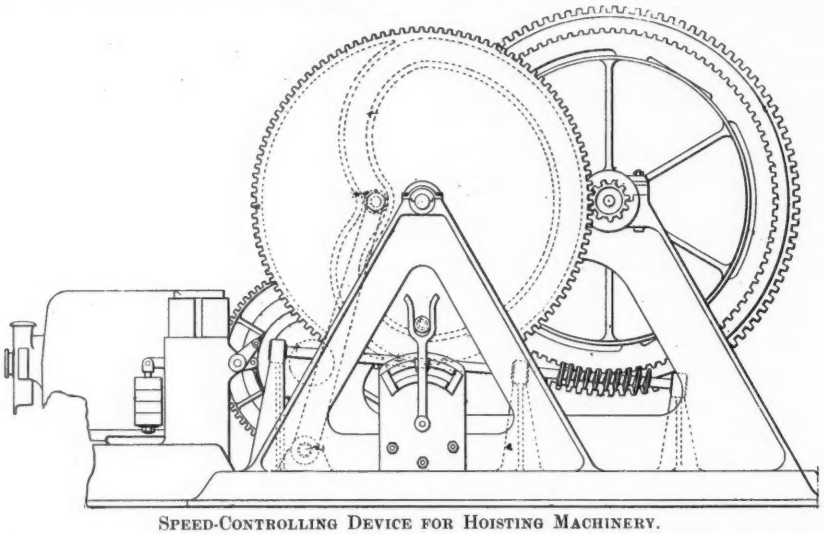
Alexander Melville Bell, father of Professor Alexander Graham Bell, died at the home of the latter in Washington, D. C., at nine o'clock on the morning of August 7, in the eighty-sixth year of his age. His death was due to pneumonia following an operation for diabetes performed the previous Tuesday. He was born in Scotland and was a son of Alexander Bell. He was one of the representatives of three generations noted for their development of the art of instructing the deaf and dumb in methods of communication. The interment took place at Washington Wednesday.

Alexander Melville Bell, the inventor of "visible speech," was born in Edinburgh on March 1, 1819, and received his education in the university of his native city. His father, Alexander Bell, was a professor of elocution in London, and young Bell secured most of his early training under him. Returning to Edinburgh, he soon won for himself the highest reputation as teacher, lecturer, and author. He married Eliza Symonds, the only daughter of Surgeon Symonds of the English navy.

Mr. Bell came to America in 1868, and was engaged in lecturing through the United States and Canada until 1871, when he settled in Brantford, Ontario. He took up his residence in Washington at the solicitation of his son, Alexander Graham Bell, in 1881, and engaged in literary work. His numerous publications on elocution, vocal physiology, and defects in speech, phonetics, and visible speech, and phonetic shorthand writing are accepted authorities on these subjects. In 1885 he was elected a member of the American Association for the Advancement of Science. He was an active member of the Modern Language Association and of various scientific and educational organizations. He also held a fellowship in the Educational Institute in Scotland, and in the Royal Scottish Society of Arts.

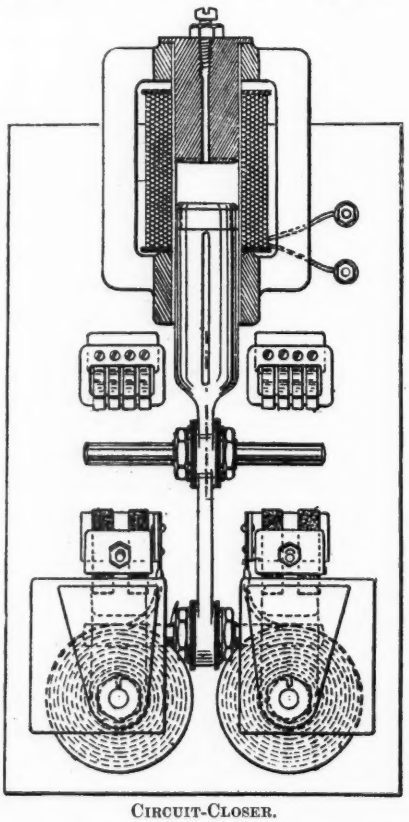
Electrical Patents.

The Electric Controller and Supply Company has obtained control of a patent (795,641, July 25, 1905) granted to John McGeorge, of Cleveland, Ohio, on a speed-controlling device for hoisting machinery. The invention relates to improvements in systems designed to operate automatically to hoist and lower skips or buckets, as, for example, in connection with the charging of blast furnaces. It is the object to provide a relatively simple system which, while operating to a great extent mechanically, shall start a load from rest, bring it up to full speed, and then bring it to rest with a minimum expenditure of energy, as well as with a minimum strain on the hoisting apparatus. A further object of the invention is to provide mechanism operated as above noted which may be driven by a continuously operating motor. The invention comprises a motor, a driven structure, and means including a clutch for connecting the structure to the motor. A brake is constructed to retard the movement of the driven structure at any point of its operation. An electric switch is provided having automatic controlling means actuated from the motor, and connections are employed between the switch, the clutch, and the brake arranged to cause release of the clutch and immediate application of the brake when the switch is operated.



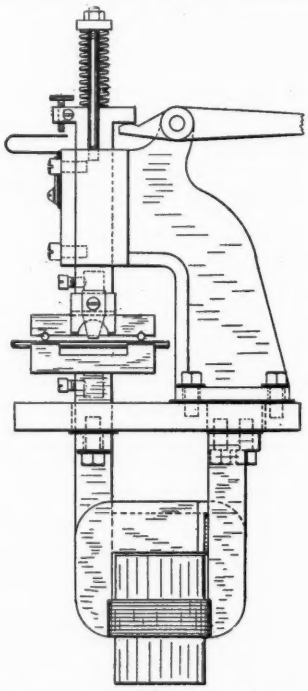
SPEED-CONTROLLING DEVICE FOR HOISTING MACHINERY.

Eugene R. Carichoff, of East Orange, N. J., has devised and patented (795,340, July 25, 1905) a circuit-closer, the entire interest in which he has assigned to the Sprague Electric Company. The invention relates to a circuit-closer in which the circuit is made and broken between suitable contacting surfaces by the reciprocation of one of the members. The construction is such that the contacting surfaces are perpendicular or approximately so to the direction of movement by which they are brought together and is also such that the surfaces rub on each other transversely to the direction in which the power is applied in bringing them together, so that the surfaces are polished and kept in condition for affording the best electrical contact. The full force of this power is therefore expended in forcing the surfaces in contact, and the construction which permits of the transverse movement is such that it does not impair the force of the power which is expended in bringing the surfaces together. For the proper breaking of the circuit the construction is such that the reciprocating member in separating the contacting surfaces acts with a considerable mechanical advantage, so as to ensure their separation in event of the surfaces having become welded or stuck together. This is accomplished by mounting one of the contacting members so that it will have a slight rocking movement and cause one of the contacting surfaces to slide transversely over the other before separating.



CIRCUIT-CLOSER.

A patent (795,541, July 25, 1905) obtained by John C. Perry, of Clinton, Mass., on an apparatus for electric welding has been assigned to the Clinton Wire Cloth Company. The invention relates to an apparatus for making a plurality of welds simultaneously. In carrying out the invention, the cooperative elements of an electric welding apparatus are provided, together with a plurality of electric welding jaws and a plurality of plungers carrying movable welding jaws. Connections are provided between the plungers, which connections carry circuit-breaking means, whereby the movements of the connections to break the welding circuit is controlled by the average amount of movement of the plungers.



APPARATUS FOR ELECTRIC WELDING.

Memorial Tablet to Sir Humphry Davy.

A tablet to the memory of Sir Humphry Davy was unveiled by William Marconi, at Clifton, Bristol, on Friday, July 14. The tablet is to be placed on 3 Rodney place, Clifton, in which house Sir Humphry Davy lived for a time.

NOTES ON THE INDUCTION MOTOR AS GENERATOR.[1]

BY T. P. E. BUTT.

It has been known almost from the initial invention of the asynchronous alternating motor, generally known as induction motor, that, if connected to its supply mains and driven at a slightly higher speed than synchronism, it reverses its usual function and becomes a generator. This knowledge, however, does not appear to have been put to any extensive use, at least not in a commercial sense,[2] and even in cases where applied, very few details are obtainable to allow one to form an opinion of the actual value of such machines.

There is another point in such machines equally interesting, and perhaps more useful, demonstrated by Danielson, and published in the *Elektrotechnische Zeitschrift* about two years ago. He described a method of converting an alternating-current motor from asynchronous to synchronous, by suitably exciting the rotor with continuous current. This is a point for which much use should be found, for such machines, in addition to possessing the inherent qualities of the synchronous motor, are self-starting. In order to effect this the motor is started up as an induction motor on light load, so that its speed approximates synchronism. At the right moment the rotor lines are switched over from the resistance to a suitable source of continuous current, which pulls the rotor into synchronism, and maintains it at this speed. Such machines should be of use on inductive systems to raise the power-factor, where such an inflexible arrangement as the ordinary synchronous motor may not find favor.[3] Circumstances having placed the writer in a position to test the above principle, he assumed that the converse would hold good—that is, if power were applied to the rotor shaft, and its windings supplied with continuous current, the outcome would be a successful generator. The results are given in this paper, and, although not obtained under favorable conditions, are of interest.

About two years ago, when it was decided to augment the lighting supply of Johannesburg from the electrical plant of the Robinson Deep Gold Mine Company, it was found necessary to obtain an additional generator to provide a reserve for the existing plant, in case of accidents and to allow for general repairs. The management did not at first fall in with this idea, and the project temporarily fell through. It happened, however, that a 300-horse-power, 2,000-volt induction motor, originally intended for operating a hoist, had been laying dismantled on the property for several years, and the suggestion of the writer to convert this into a generator was entertained and adopted. It should be explained here that the generating plant consisted of two direct-coupled, three-phase, 250-kilowatt machines working at 2,100 volts, sixty cycles, and the power demand was such as to require one generator constantly running, the second assisting on the peak of the load for several hours during the day, while from 4.30 P. M. till midnight this second generator was loaded and often overloaded for the municipal supply, and although in case of accident to either generator the mine requirements would have had first consideration, the town supply was sufficiently remunerative to warrant the installation of another machine. Owing to the difficulty in getting at short notice an engine suitable for driving this machine, it was arranged to operate it from one of the mill engines, a 500-horse-power, single-crank, compound engine having at that time a surplus of about 300 horse-power. A friction clutch and pulley were attached to an extension of the line shafting and rope-drive provided. This necessitated the location of the generator in a wing at the extreme end of the power-house, in a position invisible from the main switchboard.

To use the generator synchronously involved very little alteration to the existing apparatus. The windings, of course, remained the same, but it was necessary to make provision for a variable speed for this machine, which, unlike the ordinary generator, requires a slight increase of speed to take an increased load. To get a variable speed from the mill engine was out of the question, and recourse had to be made to other means—*viz.*, magnetic slip. This demanded the installation of the huge rheostat which originally formed the controller. This method would not be an efficient one if constantly used, but this was not intended, its use being restricted, as a rule, to the short period of time required in putting in or taking out of parallel with another generator to regulate the transfer of load. This arrangement demanded a permanent increase of speed above that of synchronism, and an increase of five per cent was allowed, which was as much as possible, taking independent working into account. The controller was located near the generator, and operated by motor from switchboard, the position of its axle being indicated by luminous signals. The arrangements for asynchronous running were practically complete, but for independent working an exciter was required suited to the rotor winding, and for this purpose a disused plating dynamo was found having a capacity of 600 amperes at thirty volts. A low-tension panel was located near the generator, and the rotor windings brought to it, provision being made for rapidly connecting them to either the exciter or controlling rheostat.

It may be opportune at this point to give a short non-mathematical explanation of the action of asynchronous generators, which differs in some points from that of the regular generator, and is not generally understood by practical men. Taking the ordinary polyphase induction motor, here we have a shifting magnetic field in the stator, as a resultant of the combined action of the primary currents. The torque on the secondary (usually the rotor) due to currents generated in its conductors by cutting this flux, is proportional up to a certain limit to the difference in the relative speeds of the primary flux and the revolving element, and is practically proportional to the load. Beyond this limit the torque starts to fall off, owing to magnetic leakage caused by the heavy currents in rotor and stator, and if the load is not reduced the rotor comes to rest. If such a motor is now connected to the supply mains on no load, it will attain a speed practically equal to that of the primary field, the slight difference being necessary to allow sufficient cutting of flux to generate currents in the rotor f the magnitude required to overcome windage and friction. These currents will be in a direction tending to diminish the elative motion of primary field and rotor. If power is now applied to accelerate the rotor shaft, then, as it approaches synchronism, the current will diminish, until at synchronous speed the working component nearly vanishes, leaving a wattless current, and we have practically an unloaded transformer, the bigger magnetizing current being due to the air-gap and the disposition of the winding, this current being just sufficient to magnetize the core to the extent required by the back electromotive force. Now, still keeping the primary connected to the mains, increase the rotor speed, its conductors again cut the primary flux, but in an opposite direc-

[1] Paper read before the South African Association of Engineers on May 6, 1905.

[2] Induction motors are used for electric traction on mountain lines. When descending a hill electricity is forced back into the trolley wires, and a braking effect is produced, the machine acting as a generator.

[3] This method might be noted in connection with the electrical driving of stamp batteries.

tion. The currents now generated, instead of utilizing their energy in wiping out the primary magnetism, the source of the back electromotive force, are reversed and reenforce it, thus tending to raise the stator back electromotive force above the forward, and force current back into the line. If the rotor speed is still further increased more currents are induced, the stator back electromotive force tends still further to rise, and more load will be taken; and if the capacity of this machine is sufficient and has the necessary power behind it, the load on the system will be transferred to it, and steam can be shut off the regular generator or generators supplying the system, upon which they will continue to run as motors, and supply the magnetizing current.

Now, compare some of the characteristics of this machine with that of the ordinary synchronous generator. The expression (pairs of poles by revolutions per second) will not give the correct frequency, but higher, the difference being due to the relative motion of the secondary conductors with reference to the primary field, which must occur to produce the rotor currents, or in other words, this is the negative slip; and the amount of this slip to assume a certain load will depend on the rotor resistance. The frequency will be determined solely by the currents supplied it by the synchronous machine regardless of its own speed. The speed, however, must not rise above a certain critical value, or the power required from the prime mover will fall off rapidly, due to magnetic leakage, as in the case of the motor. Provision then must be made for this in governing the engine, or should this point be exceeded the engine might run away.

Another point, the power-factor. This will be dependent on the amount of load supplied to the system, but independent of the nature of such load, so that any currents demanded by apparatus employed on the system not in phase with the working current must be supplied by the synchronous machine. Paralleling is, of course, a simple matter, there being no need for synchronizing; it is always better, though, to get the speeds as near as possible to avoid disturbance to the system, if the machine is of large relative capacity. The possibility of running such machines for boosting purposes, as suggested by M. Le Blanc, will not be touched on here, but is mentioned as another addition to its area of usefulness.

Now, turning to another function of this machine. The synchronous part of the operation requires little or no explanation; the rotor is simply transformed into a field magnet with a continuous iron surface, instead of the usual definite polar projections. Anticipation of serious magnetic leakage in this method can be referred to results. The first trial took place under asynchronous conditions; the machine, it should be stated, has a distributing winding, three slots per phase per pole in stator and four in rotor, the number of poles being twenty-four, so that the permanent speed was 315 revolutions, or five per cent above synchronism at sixty cycles. At this speed or near it, and with the rotor resistance all in circuit, the switch was closed on the bus-bars, thus paralleling it with a synchronous generator which at the time was delivering ninety kilowatts. A current equivalent to thirty per cent of the non-inductive full-load current was taken, and under these conditions the disc movement of a sensitive watt-hour meter in circuit was scarcely perceptible; the resistance was then cut out, until the whole load was taken, and steam was then shut off the synchronous machine, which continued running as a motor. After this steam was again admitted and the load increased and distributed by means of the rheostat on the two machines until a combined load of 362 kilowatts was carried, out of which the induction machine supplied 170 kilowatts. This was the limit attained and was determined by the speed of the mill engine, which was not well governed, and at this point became unstable, thus causing sudden transfers of load between the generators, and big voltage variations. A higher limit would have been obtained with a more favorable load—that is, motors of relatively small capacity or lights—but nothing less than fifty-horsepower motors were available, and the switching on of such at this stage would cause a marked fall in speed of the mill engine, upon which heavy surgings of current would take place, knocking the voltage beyond control and dislocating the service.

The machine was next tried as an independent generator. More interest was attached to this test, as if the operation proved successful, this method of working would have considerable commercial value. Two methods of exciting the rotor were available, either by cutting out one branch of the winding altogether, and connecting the other two in series to form the path for the current, or by connecting two branches in parallel and putting the combination in series with the third. This latter method was found to be more economical in exciting current. The trials under these conditions and with an induction motor load resulted in attaining an output of 180 kilowatts before the engine governing gave trouble. The excitation at this load was seven kilowatts. On a lighting load the results were extremely satisfactory, the output limit being largely increased—in fact, on certain occasions of big demand at the municipal lighting station, loads up to 315 kilowatts have been delivered with an excitation of 330 amperes at 25.5 volts. The engine under this load had got beyond governor control and fallen four per cent in speed, but beyond this showed no signs of distress. This load, however, was abnormal, the maximum seldom exceeding 260 kilowatts. The excitation required at no load was 138 amperes at 9.5 volts, or 1,311 watts as against twenty-seven amperes at 133 volts (3,591 watts) for the regular generator. At loads of 180 kilowatts on similar power-factors of approximately 0.75 the excitations were 6.4 kilowatts and 5.2 kilowatts respectively; here the longer air-gap of the regular generator tells to advantage. On similar loads (lighting) of 220 kilowatts the order is reversed, the regular generator requiring 5.2 kilowatts against 1.5 kilowatts of the converted machine.

The results on the whole must be considered good. With a constant speed at the prime mover, higher limits would have been reached on motor loads; part of this was due to the governing, but large steam pressure fluctuations played no inconsiderable part, and this was in a measure unavoidable, owing to the fact that two large winding engines were supplied from the same battery of boilers. The excellent results obtainable on non-inductive loads, neglecting the part due to less armature reaction, were attributable to the gradual assumption of the load, under lighting conditions, as distinguished from the sudden changes caused by switching on motors of large relative capacity, when on inductive loads. The temporary pulling up of the prime mover under the latter conditions was, of course, noticeable on lighting loads when heavy banks of lamps were thrown on; but this occurred very seldom, and it is obvious that, although inconvenient in such cases, it had not the dangerous factor which such occurrences might mean to motor loads. This machine offers another field of usefulness as a motor, and with its present connections can be used in case of emergency to drive half the mill (100 stamps), no change at

all being necessary beyond disconnecting the mill engine.

To sum up, then, it must be admitted that under the disadvantageous conditions prevailing, good results have been obtained as far as the object in view was concerned. With more power at our disposal, and under our own undivided control, still better results could have been looked for on inductive loads. Asynchronous working increased either generator capacity by about forty-five per cent, and was sufficient to ride over the peak of the day load. The heavy wattless current is a serious trouble, and reduces to a great extent the advantage obtained in other directions. It could be neutralized by the use of a static condenser, but condensers of the size necessary here (capacity thirty-five microfarads) can scarcely be called commercial apparatus, and would be expensive and difficult to obtain here. Independent working was certainly a success, and up to the time of the writer leaving the company it was nearly always used as such. The short air-gap and low flux density in the rotor, although favorable as a motor, allowed a big armature reaction when generating on inductive loads, but the effects of this would not have been so noticeable with automatic voltage regulation, such as, say, the Tirrell system. As to the use of such machines in mining districts, such as the Witwatersrand, it depends entirely on circumstances. No doubt in the near future isolated electric generating plants will disappear, and be replaced by central supply stations, operating over suitable areas. When such a system is actually in sight, any immediate addition to the generating plants of mines likely to be affected by the change could be provided for by a machine such as described, which, on conversion of the systems, could at once resume its original rôle as a motor.

Curtis Steam Turbines in Japan.

Characteristic of the present progressiveness of Japan, is the fact that outside of Europe and the United States this small nation is the largest user of steam turbines in the world.

With the industrial awakening of the Island Empire has come a need for electric power not only for manufacturing purposes, but for transportation and for lighting. Japanese engineers are wide awake, and their enterprise is nowhere more clearly indicated than in their adoption of steam turbine electric generating units, which in other parts of the world are so rapidly replacing the old style reciprocating engines in the electrical field.

On July 29, 1904, the first shipment of steam turbines arrived in Japan *via* the steamship Korea from San Francisco. They were of 500 kilowatts capacity of the Curtis type, and were for operating the Shigai railway in Tokio. Four weeks from their arrival they were in full operation. As significant of the success of these first units, there have been ordered by the Japanese from the General Electric Company, of New York, thirty-seven Curtis steam turbines with electric generators with a total normal capacity of more than 35,000 horse-power. Of these, eleven units are now installed and in satisfactory operation.

Japan is not slow in adopting the electrical systems which will improve her manufacturing and transportation facilities and give her people better lighting service. They are using electricity for operating the street railways of their cities and for indoor and street lighting. In the use of electric power for machine shops, they are following only the best American practice, which, as a rule, requires electric motors mounted on each tool.

The coal mines of Japan will eventually be operated electrically. Some of the turbines mentioned above are intended for the Miike coal mines on the Island of Kyushu. These are owned by Mitsui & Company and will use two 1,000-kilowatt Curtis steam turbines.

The Osaka Electric Light Company, which furnishes electricity to the city of Osaka which has a population of over 800,000, is equipped entirely with American electrical apparatus, including six steam turbines of the same make. The capital of this company is 2,400,000 yen, and with its progressive methods it will soon rival some of our modern American illuminating companies.

One of the largest electrical interests in Japan which has ordered some of the machinery referred to above is the Tokio Street Railway Company which furnishes transportation facilities for the city of Tokio which has a population of 1,440,000. Its Japanese name is Tokio Shigai Tedsuda. Its franchise runs until 1952. The franchise provides that after the year 1932 the municipality may purchase the property of the company by paying a proper price for it. Its capital stock is 15,000,000 yen, divided into 300,000 shares.

Although some English and German material is being used by this road, practically all of the electrical equipment is American made. This includes five 2,000-horse-power Curtis turbo-generator units with power-house equipment and railway motors furnished by the General Electric Company, Wheeler condensers and Brill trucks. Besides a small amount of German and English machinery such as boilers and trucks, there are a few small dynamos which were made in Japan.

Railway between Belgium and Germany.

Consul McNally, Liege, Belgium, writes: the Belgian administration has asked the congress to appropriate $10,615,000 for a new railway into Germany *via* Louvain, St. Trond, and Argenteau. A convention between Belgium and Germany, held at Berlin, August 15, 1903, had for its object the building of this as well as a smaller railway connecting Stavelot in Belgium with Malmedy in Germany, for which latter enterprise an appropriation of $308,800 is asked.

The new line will help to meet the close competition of the Dutch railways. Every effort will be put forth not only to make travel as comfortable as possible, but to increase the speed of the trains as far as is consistent with the safety of passengers. It is hoped that the speed will reach 120 miles an hour with the use of modern electrical appliances. With this end in view many new ideas will be adopted in the construction of the road. There will be no grade crossings, the grades will be light, and the radius of every curve will be at least 2,000 yards.

The projected road will not only establish rapid international connections, but will connect central Germany with Antwerp, which is the port of entry into Belgium. This determination of the government to build a new road into Germany caused some apprehension on the part of the inhabitants of the cities now on the main international line. The government has announced that it is not its intention to use this road for all international trains, and that the cities of Liege and Verviers will not suffer in consequence. These cities will remain on the route which forms the best line between France and Germany (by Charleroi and Namur).

The opening meeting of the summer session of the British Association for the Advancement of Science at Cape Town and Johannesburg, South Africa, will be held on August 15, at Cape Town. Professor H. H. Darwin, president, will deliver his inaugural address.

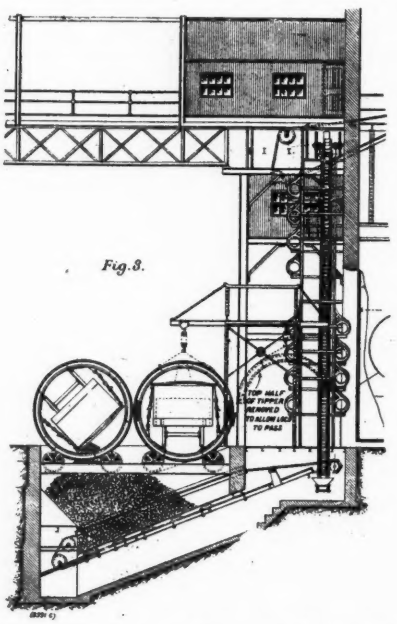
Reviews of Current Engineering and Scientific Literature.

The Testing of Alternators.

This is a study by Stanley P. Smith. There have been several different suggestions as to the best means of testing a single alternator in some way akin to the well-known Hopkinson test for direct-current machines. Mordey divided the armature circuit so that part of it acted as generator and the rest as motor. Thus he might divide a twenty-coil armature into a generator of twelve consecutive coils, and the remaining eight coils with the connections reversed in them gave energy back to the machine. Professor Ayrton modified this arrangement by splitting the field instead of the armature. In this case opposite halves of the field were magnetized to oppose one another, the armature being short-circuited through an ammeter. Behrend found that by exciting eight coils as a generator and four as a motor, using the same current in both parts of the field, that the magnetic strain was sufficient to endanger the machine by reason of the severe mechanical stresses set up. He thus split the field into two equal parts, using six consecutive coils to generate, and the other six to motor. But to counteract for the demagnetizing effect of the lagging armature current in the generator field and its magnetizing effect on the motor field, he used a stronger exciting current in the former than in the latter. The results obtained from this modification seemed to be very satisfactory. For the purpose of research it was thought, therefore, that this method might be applicable in testing a thirty-kilowatt, single-phase, twelve-pole alternator. It was found to be dangerous to put full current through the armature. It was noticed that to obtain any armature current, the generator part of the field had to be much more strongly excited than the motor part. The arrangement of using six alternate coils as generator and six as motor acted splendidly. Another method suggested is the modification of Mordey's, since the same exciting current is used both in generator and motor coils, the respective fields being symmetrically placed around the armature. In this case it was found with eight generator coils and four motor coils, an extensive field current was needed to yield full current in the armature, but with ten generator coils and two motor coils, a splendid result was obtained with a normal field.—*Abstracted from the Electrician* (*London*), *July* 14.

A Modern Coal-Conveying Plant.

A coal-conveying plant of quite extensive proportions has been installed at the works of the Metropolitan Electric Supply Company, Limited, Willesden Junction, London, England. The installation was designed for the handling of small coal at the rate of from sixty to eighty tons per hour, and conveying it from the trucks to the boiler furnaces. In this system the loaded wagon or coal truck is turned over bodily and its contents falling into a hopper to receive it pass thus to the conveyer which distributes it to overhead storage bunkers. Opposite the boiler house there are two main lines of railway, and a large coal bunker of seventy tons capacity has been built below the coaling lines. Immediately over the top of this bunker there are mounted two Bennis rotary side-truck tippers. These tippers enable the trucks to be completely turned over to be emptied. The tippers are so arranged that the upper half is lifted off to allow a locomotive to pass through. The wagon is secured in the tipper by clamps which when tightened up hold it securely in place. The clamps are fitted with a strong compensating mechanism to take up any shock. When the wagon has been secured, the attendant, by means of a switch, sets a five-horse-power electric motor in operation which rotates the tipper containing the truck and delivers the fuel into the receiving-hopper. An especially interesting point to be noticed in the design of this tipper is that by its complete revolution it saves trimming, while emptying every ounce of coal. It rests on a series of rollers, each side being actuated by a reversible electric motor. Each tipper is capable of emptying one hundred tons of coal per hour. The apparatus has been constructed by Messrs. E. Bennis & Company, Limited, of London, England.—*Abstracted from Engineering* (*London*), *July* 14.



ELEVATION, SHOWING METHOD OF OPERATING COAL TIPPER.

A French 28,000-Volt Power Transmission.

A very interesting high-voltage transmission is that recently placed in service by the Societe Energie Electrique Du Littoral Mediterranean. This plant is to supply power to Toulon. The company has in service several power transmissions of 10,000 and 12,000 volts, but the present scheme, in which 28,000 volts is employed, is an advance of anything of this nature previously attempted in France. The line has a length of about fifty-eight kilometres. The service is principally used to supply the needs of the town in respect to lighting and also to the tramway system of Toulon. In addition to this, however, it supplies energy for lighting and power to several villages in the Var district along the transmission line. This installation makes an important addition to the existing generating plants of the company, and forms the commencement of a large scheme of extensions. The generating station is situated in the River Argens at Entraygues near Vidauban (Var). It utilizes a natural flow of the river followed by a series of rapids. The dam and the hydraulic works have been designed to allow for storage of sufficient water to take care of the peaks in the load, and the length of the crest of the dam is sufficient to allow the distribution of the yearly floods to the river without flooding the land lying above the station. The conduit leading to the station is in the form of a ferro-concrete tube 2.9 metres in diameter, working under a pressure averaging from twelve metres at low water to fifteen metres during floods. The generating plant includes three main units which are composed of a 1,000-horse-power double turbine with a horizontal axis on the Francis system, direct-coupled to the three-phase alternator of 700 kilowatts capacity. The main turbines are designed to operate under a

head of water averaging from fifteen to twenty metres, with a maximum exhaust of 6.6 metres from the floor level of the turbines to the water level in the feeding canal. The normal speed of the turbine is 300 revolutions per minute. By means of turbine regulators the speed can be varied five per cent under or over the normal, the control being either by hand or at a distance by means of a small electric motor operated from the switchboard. The alternators are thus easily synchronized and the load can be evenly divided between the units from the switchboard. The alternators are of the fixed armature revolving-field type. The excitation of the alternator fields is effected by means of two thirty-kilowatt sixty-volt dynamos, one being spare. These are operated by seventy-five-horse-power turbines at a speed of 600 revolutions per minute. Each of these dynamos is rigidly coupled to another machine on the same base, developing at least twenty kilowatts at 600 revolutions per minute, giving under compound excitation a constant pressure of 110 volts at the terminals. These latter machines are for the auxiliary services of the station, such as the lighting, pumping, etc., so as to be independent of the exciting circuit. To step-up the three-phase current, there are three transformers, one for each generating unit. These are of the air-cooled type and give an output of 650 kilowatts at a frequency of twenty-five cycles. The switch-gear is mounted on a main board containing three alternator panels, one exciter panel, one auxiliary service panel and one station panel. There is also an auxiliary board comprising three panels for the low-tension connections of the transformers, and one line panel for a 3,500-volt line. Each of the alternator panels is equipped with a triple 30,000-volt oil-switch, electrically controlled at a distance and furnished with a time limit relay for automatic tripping. In addition, there is, of course, all of the auxiliary apparatus for controlling the system. The overhead line is formed of three bare copper wires of twenty-eight square millimetres section. The double-petticoated porcelain insulators which carry the wires have a height of 170 millimetres, a diameter of 220 millimetres on the upper petticoat, and weigh 2.6 kilogrammes without the support. In addition to the generating station at Entraygues, there are two substations, one at Brunet, Toulon, and another at Loubiere. There are also two smaller stations fed from the 30,000-volt line between Toulon and Entraygues. All the instruments in use for these installations were supplied by the General Electric Company, Schenectady, N. Y., and the whole installation has been carried out by the French Thomson-Houston Company, the generators and other moving machinery being built at the company's Paris works.—*Abstracted from Electrical Review (London), July 21.*

Steel Rail Industry.

In transmitting the following abstract of two articles which recently appeared in the *Deutsche Bergwerks-Zeitung,* giving the history of the steel rail industry of the United States, Consul H. W. Harris, of Mannheim, Germany, says that the view taken by the journal just named of the outlook of the American rail industry may be accepted as that which prevails among well-informed Germans:

The vast concentration in the manufacture of American steel rails has rendered the United States able to enter into the sharpest competition with England and Germany in the export of rails. Prior to 1890 the export of rails from the United States never amounted to more than 8,000 tons in any one year; in fact, the country had large imports of rails. For example, in 1881, the imports were 296,000 tons; in 1882, 118,000 tons; in 1887, 77,000 tons; in 1888, 137,000 tons. With the year 1890 the United States began gradually to become a factor in the export of rails. These exports were in 1890, 10,000 tons; 1895, 12,000 tons; 1900, 348,000 tons; 1904, 161,000 tons.

EXPORTS OF RAILS FROM ENGLAND, GERMANY AND THE UNITED STATES FOR FIFTEEN YEARS.

Year.	England. Tons.	Germany. Tons.	United States. Tons.
1889–1891...	681,000	128,000	11,000
1892–1894...	390,000	107,000	13,000
1895–1897...	512,000	120,000	51,000
1898–1900...	443,000	130,000	286,000
1901–1903...	531,000	255,000	185,000

The record in the export of rails during the last ten years was made by England in 1903 with 604,000 tons, by Germany in 1903 with 379,000 tons, and by the United States in 1901 with 375,000 tons. It will be seen how the United States, which in the eighties imported at times 10,000 tons and more of rails per year, has now become an important factor in the export trade. This has been due in part to the low price made by Americans for rails as well as to concentration, the low price being in fact partly the result of competition.

EFFECTS OF TARIFFS.

From 1875 on, the duty on rails was fixed at $28 per ton, and was by further reductions made, respectively, $17, $13.50, and in 1894 $7.75 per ton, the latter being since that date unchanged. This continuous protective policy has helped the American rail industry onto its feet, and finally has rendered it able to manufacture rails much cheaper than the English, who were formerly the rail makers of the world.

COST OF RAILS PER TON IN ENGLAND AND IN THE UNITED STATES.

Year.	England.	United States.	American Duty.
1875.....	$48.66	$59.80	$28.00
1880.....	35.53	67.50	28.00
1885.....	26.76	28.50	17.00
1890.....	26.52	31.70	13.50
1895.....	27.25	24.30	7.75
1898.....	28.47	17.60	7.75
1900.....	30.42	32.30	7.75
1901.....	28.22	27.30	7.75
1902.....	26.52	28.00	7.75
1903.....	26.03	28.00	7.75

In the year 1875 the protective tariff on rails was $28 per ton, or 50 per cent ad valorem. In the years 1901-3 American rails cost $28 per ton, that is, the same amount as the duty had been twenty-four years before, the duty in the years named being 28 per cent ad valorem. From the year 1894 to 1898 American rails were cheaper f. o. b. factory in Pennsylvania than the English product f. o. b. at the English coast. At present the prices are about the same. The difference has since the year 1900 amounted to from $1 to $1.50 per ton.

PRODUCTION OF RAILS IN GERMANY, ENGLAND AND THE UNITED STATES.

Year.	Germany. Tons.	England. Tons.	United States. Tons.
1890.....	559,000	.....	1,522,000
1895.....	493,000	604,000	1,021,000
1900.....	903,000	760,000	2,273,000
1902.....	921,000	903,000	2,875,000

CONCLUSION.

Thus the United States produces more rails than Germany and England combined. The American steel rail industry can, in view of the facts, look back with satisfaction on the forty years of its development. American steel rail manufacture is to-day so powerful that, except for some extraordinary circumstances, it is able to supply the demand of the country and to furnish in addition a fair amount of export. The present capacity of steel rail manufacture in the United States is estimated at from 3,250,000 to 3,500,000 tons. The fact that the United States has become an export country for rails will probably become more apparent, year by year, in the future.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A Vertical Cross-Compound Generating Set.

The B. F. Sturtevant Company, Hyde Park, Mass., is building for the general trade a generating set possessing a number of features of unusual interest, combining in its design the best practice of American and European builders. This set was originally designed and built for the United States navy department, and the apparatus has been subjected to very thorough tests in order to satisfy the rigid requirements. The apparatus which is now being turned out for the trade is constructed and tested in the same thorough manner as the machines which won the approval of the navy department.

The accompanying illustrations show the detail and assembly of the vertical 10 by 18 by 10 cross-compound type, direct-connected to a 35-100 MP-10 generator of 100 kilowatts capacity. The following table gives the general proportions of this set, as well as the dimensions of several similar sets built by this company.

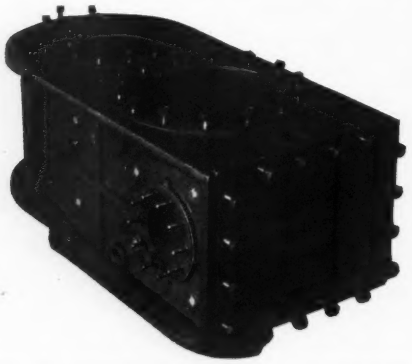


FIG. 2.—HIGH PRESSURE AND LOW-PRESSURE CYLINDERS AND STEAM CHEST.

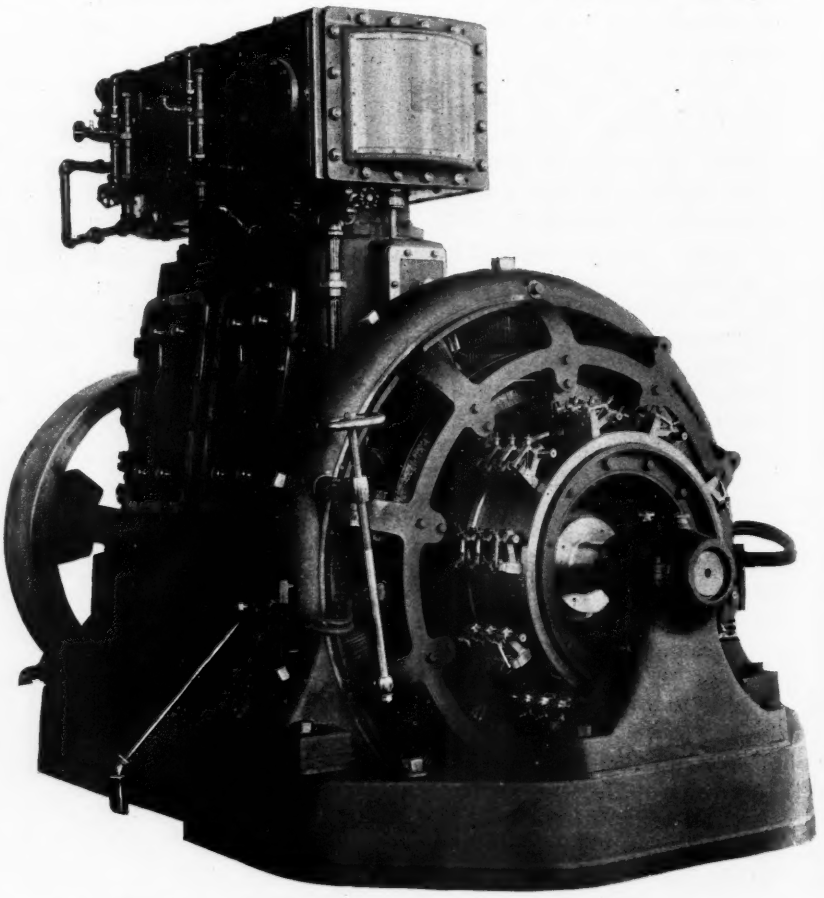


FIG. 1.—VERTICAL, CROSS-COMPOUND ENGINE, DIRECT-CONNECTED TO 100-KILOWATT DIRECT-CURRENT GENERATOR.

Size of Engine.	Steam Pressure Required. Pounds.	Revolutions per Minute.	Pipes.		Crank Pin. Diameter by Length.	Shaft. Diameter.	Kilowatts.	Weight Complete Set. Pounds.
			Steam	Exhaust.				
6¼x10½x6¼	100	450	2	2½	3½x3½	3½	17½	5,600
7x12x7	100	400	2	3½	3¾x4	3¾	25	7,300
8x14x8	100	400	3	5	3¾x4	3¾	35	10,000
8x14x8	150	400	3	5	4½x5½	4½	50	14,000
10x18x10	150	350	4	6	5½x6½	5½	100	22,000

A remarkable feature of these sets is their high mechanical efficiency, averaging considerably over ninety per cent. This is partly accounted for by the system of forced lubrication, which by means of an oil pump accessibly located in the base supplies oil to the bearing at an average pressure of fifteen pounds, the course of oil being to the main bearings, along the shaft, up the crank webs to the pins, and thence up the connecting-rod to the cross-heads and guides. The frame of the engine is fitted with hinged oil-tight doors on the sides, and removable plates at the ends, giving ready access to the reciprocating parts. There is also a watershed partition between the case and the bottom of the cylinders. This serves to prevent oil from the reciprocating parts being carried into the cylinders, and keeps the water from the cylinders from being mixed with the oil. This arrangement, at the same time, allows convenient access to the piston and valve rod stuffing-boxes when the engine is running. Centrifugal oil-throwers are set at the bearings between the engine and the generator, and between the engine and the governor wheel, and complete the scheme for making the apparatus absolutely oil-tight, and guarantee the protection of the generator from oil creeping along the shaft.

Both the high and low-pressure valves are double-ported and balanced. The high-pressure valve is of the piston type, and the low-pressure a slide valve arranged to lift from its seat for the escape of entrained water. The steam and exhaust outlets are so placed that the engine may be conveniently piped from either side.

Fig. 1 shows the generating unit completely assembled; Fig. 2, the high and low-pressure cylinders and steam chest, and Fig. 3, the engine base with bearings and shaft.

The piston rods are secured to the pistons by a taper fit and nut. The rods are made of high carbon steel, and the pis-

tons are of cast iron with specially turned snap rings, ensuring a perfect cylinder fit. The cross-heads are fitted with adjustable steel shoes and with bronze boxes for the cross-head pins, which are pressed into a fork at the end of the connecting rod and doweled in place. The coupling for direct-connecting to the generator is forged on the crank shaft, which is made

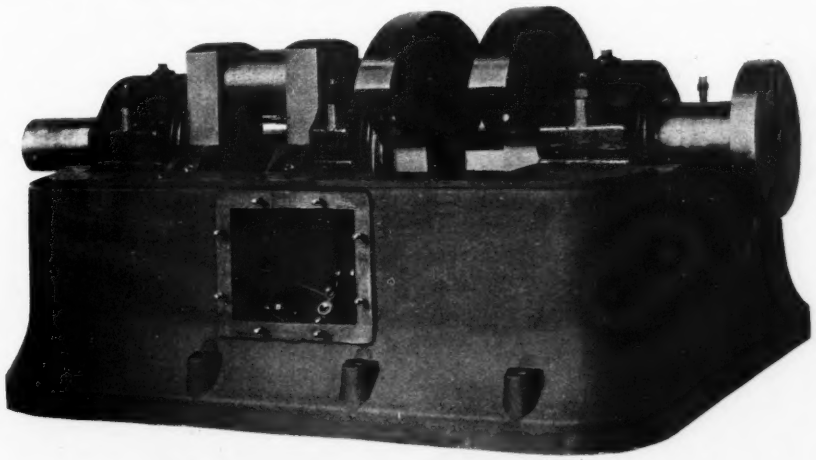


FIG. 3.—ENGINE BASE WITH BEARINGS AND SHAFT.

in one piece of high-grade forged steel with cast-iron counterweights securely bolted thereto. The cranks are set at an angle of 180 degrees. The main bearings are lined with Sturtevant white metal, the lower halves being removable by revolving around the shaft. Fig. 4 shows the crank shaft with counterweights and coupling, the high and low-pressure piston rods and pistons, the connecting rod, and

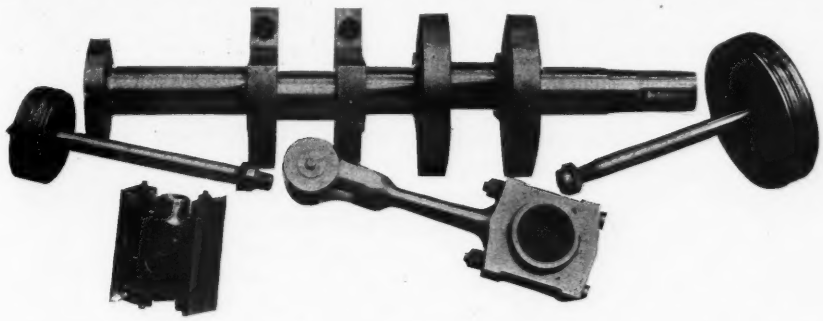


FIG. 4.—ENGINE DETAILS.

a cross-head guide with the bronze boxes in place.

A unique feature of this engine is the indicator gear, which is so arranged that cards may be taken without interfering with the oil-tightness of the case. The reducing motions from the cross-heads are always in place, and automatically engage with short sliding rods which project through stuffing-boxes in the side doors. This feature is very clearly shown in Fig. 1. Speed regulation within one and one-half per cent from no load to full load is secured by a Rites inertia governor.

While the generators of these sets present perhaps nothing radically new, they are built in accordance with specifications of a very high standard. The magnet frames are of the best grade of cast iron, adjustable vertically, and divided horizontally so that by lifting the upper half the armatures may be removed. The shunt and series coils are separately wound and mounted on the pole-pieces, which have cast-iron shoes and are through-bolted to the frame to allow the removal of individual coils. This construction is clearly shown in Fig. 5.

The armatures are of the iron-clad, two-circuit, form-wound, ventilated drum type. The cores are of special low carbon steel, mounted on cast-iron spiders which have hub extensions for the support of the commutators. This construction is shown in Fig. 6. The laminations are punched from the best qualities of thoroughly annealed electrical sheet steel, are set up under pressure, and are clamped together in such manner as to obviate any liability to displacement due to magnetic drag, etc. The commutators are made up of bars or segments of pure hard-drawn copper, insulated between the segments with the best quality of selected mica, and secured on cast-iron shells of spider construction. The armatures are

FIG. 5.—FIELD FRAME OF GENERATOR.

balanced both electrically and mechanically. Fig. 7 shows the completed armature, and also shows very clearly the coupling with its through key-way.

FIG. 6.—ARMATURE CORE.

The brush rigging of these sets, which is well shown in Fig. 1, is unique in its compactness. The brush-holders are of the sliding socket, shunt type, with flexible connection to each brush, and the

FIG. 7.—COMPLETED ARMATURE AND COMMUTATOR.

holders are mounted on studs projecting from the brush rigging, so arranged as to be readily rotated for adjusting the brushes. The holders are staggered so that the brushes will wear evenly on the commutator, and each brush is separately removable and adjustable.

Sufficient brush surface is allowed so that the current density will not exceed thirty amperes per square inch of bearing surface.

All of the insulation receives a sixty-second breakdown test of 1,500 volts, alternating current, and shows a resistance of at least one megohm with an initial voltage of 500. The insulation is dampproof and unaffected by temperatures up to 100 degrees centigrade.

The generators are capable of carrying fifty per cent overload for short periods of time without shifting the brushes or sparking at the commutator. They will run continuously at twenty-five per cent overload without sparking or undue heating.

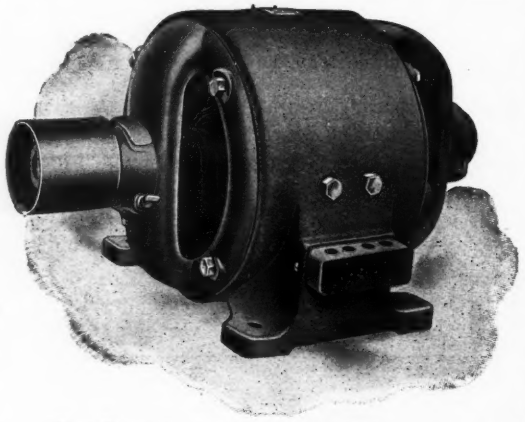
After a continuous run of ten hours the heat rise in any of the parts will not exceed forty degrees centigrade above the surrounding atmosphere. Full load may be thrown on or off without affecting the voltage over fifteen per cent.

These machines are made entirely at the works of the B. F. Sturtevant Company, at Hyde Park. The company has laid out its plant so as to secure facilities for producing everything needful in the construction of its varied line of apparatus; and as the parts of both engines and generators are made from templates, duplicates are always carried in stock at the manufacturer's plant.

Despite the extremely hot weather which prevailed over the entire eastern section of the country during the last few weeks, the F. F. Proctor circuit of theatres attracted large numbers of patrons because of the very desirable cool atmosphere which prevailed in these playhouses. In addition to the provisions made for the physical comfort of patrons, Mr. F. F. Proctor has arranged for the reappearance of some of the most skilful artists of the day. A new feature which has been adopted with the Proctor theatres is the mailing of reserved seat tickets to patrons upon the sending of a check or money order. Telephone communications also receive prompt and courteous attention.

A New Line of Small Power Motors.

The application of electric motors to general power purposes involves so many different conditions that motors for successful general use must now possess, to a large degree, all those qualities which hitherto have been considered necessary only in motors intended for special severe service. This idea has been followed closely in the design of the new line of General Electric Company's small CQ motors. They are built in sizes ranging from one-quarter horse-power to twenty horse-power and are adapted to practically all conditions of service, as their design has been laid out with special reference to simplicity and durability in construction and reliability in operation. The appearance of the new motor is attractive and symmetrical, as can be seen by reference to the illustration. The customary form of bearing support for small motors is here utilized but with added attention paid to



NEW LINE OF SMALL POWER MOTORS.

appearance as well as strength and rigidity. The end shields are simple in form and of large section, giving rigidity to the frame. They may be rotated in either of four positions, differing ninety degrees from each other to meet the requirements for various positions of installations.

The bearings encased in the end shields are lubricated by oil-flooding rings revolving in the oil reservoir below the shaft. The linings are single castings of hard composition and ample bearing surface.

The general form of the motor secures a low centre of gravity of the complete motor and a short magnetic circuit, which, combined with high-grade workmanship, give the CQ motor a notable efficiency for its capacity and enable the maker to produce a compact machine free from vibration. The cylindrical, soft cast-steel magnetic yoke is provided with feet which allow rigid connection with the support of the motor. The pole-pieces are separate from the yoke and fastened to it by through bolts permitting ready removal when repairs are necessary. The extended tips of the pole-pieces hold the field coils rigidly in position.

One evidence of the care used in the design of these motors is to be found in the construction of the armature. The armature body is insulated in a manner similar to that employed in the standard General Electric railway motors. The insulation is tough and impervious to moisture and practically indestructible. Thorough tests of the insulation of the copper wire coils are made before placing them in slots punched in the armature disc in which they are retained by steel binding wires. The arrangement of the windings in the slots is such that a large surface of copper is provided in the position best calculated to dissipate the heat and ensure cool running and high efficiency. In the larger sizes air ducts are provided for ventilating the cores and windings. The steel laminations are clamped rigidly between two cast-iron spiders or end-plates, which have flanges to support the extended ends of the armature coils.

The construction of the brush-holders and brushes is simple, utilizing that form of holder and pressure spring which has been found satisfactory for motors in general service. The motors operate with practically no sparking under variations from no load to full load and without shifting the brushes.

The standard motor will deliver its rated output with a rise of temperature in any part not over forty-five degrees centigrade above the surrounding air. It will operate with a twenty-five per cent overload for one hour, and forty per cent temporary overload without injurious heating.

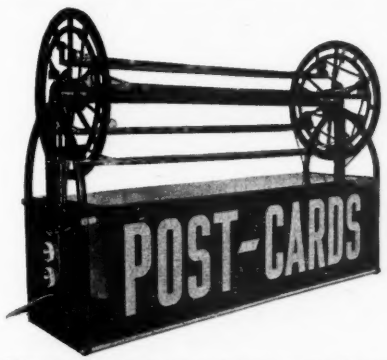
The speeds of the CQ motors have been chosen to permit direct belting to line shafts running at ordinary speeds without the use of intermediate countershafts. By the use of steel magnet frames and the employment of light but rigid end shields to support the bearings, an economy of material is effected which permits, without sacrifice of strength or stability, the construction of CQ motors much lighter for a given output than machines running at even higher speeds. The most economical speed for a given service must be de-

termined by a careful study of the relative advantages to be derived from a slow speed and the increase in cost required to obtain it. The speeds adopted for CQ motors have been found most advantageous and economical for nearly all purposes. When a lower driving speed is desired than can be obtained with a standard CQ motor, a belt-tightening apparatus is furnished which allows a driving pulley smaller than the standard one to be used and at the same time secures sufficient contact to enable the full power of the motor to be transmitted. This is particularly serviceable when a very short driving belt must be used. The loose pulley may be adjusted to any lead of the belt and in many cases avoids the adoption of a gear drive when it is undesirable.

A Revolving Electrical Display Showcase.

The accompanying illustration shows one form of an electric revolving display showcase manufactured by the Thompson-Bonney Company, Incorporated, 29 Cortlandt street, New York city.

The essential feature of this apparatus is a showcase built on improved lines of steel and plate-glass construction. Each case is built with a rotating shelf cylinder to which can be attached from four to eighteen trays according to the grades of



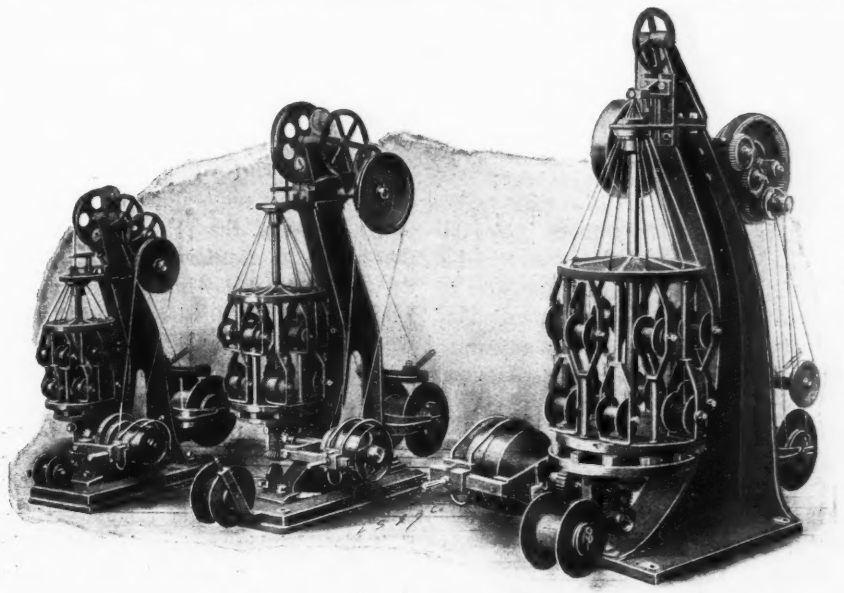
REVOLVING ELECTRICAL ADVERTISING SHOWCASE.

merchandise to be displayed. This cylinder revolves continually, and at the same time holds the trays rigidly in any position in which they are placed. The tray supporters on each end are bounded with electric bulbs. The entire cylinder thus equipped rotates so that every tray is well illuminated and brought to the top and front of the case once every minute or oftener if desired. By this means a very large amount of stock can be displayed to even a casual observer.

In addition to the ordinary construction, a variegated colored cylinder extending the full length of the case and containing one sixteen-candle-power lamp to the running foot is attached. When the current is on, and the trays with their contents are being rotated, this cylinder moves also, producing a spectacular effect, and at the same time helping out the general illumination of the case.

Vertical Stranding Machines.

The Aiton Machine Company, 126 Liberty street, New York city, has placed on the market a type of vertical stranding machine for manufacturing small wire ropes, cords, etc., light strands from copper wire for gutta-percha and rubber cores, telegraph wires, light cords, etc. These machines are designated as types A, B and C.



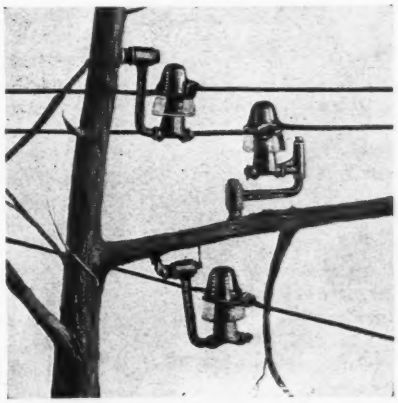
VERTICAL STRANDING MACHINES.

These machines are made for six or twelve bobbins each. The bobbins are carried in steel cradles, and are all "back-turn" geared by means of an eccentric ring. The back-turn motion of the spools keeps all twist out of the wire. This is quite necessary in the manufacture of wire ropes. Many manufacturers of electrical strands and cords deem this unnecessary, and for this purpose the company builds machines similar to type C, but without the back-turn motion in the spools. The machine is complete in itself, and requires no additional mechanism when set up.

The receiver or take-off spool on the back of the machine is located close to the floor, and the take-off or capstan wheel is provided with several changes of speed, so that the strand can be laid up on whatever twists per foot may be desired by the operator. The machine runs right or left, having automatic traverse for evenly laying up the finished strand on the receive spool. The fliers or cradles for the bobbins are made of steel, and fit into steel spiders or rings. The cradles all have the company's new tension attachment, ensuring the same tension on the successive bobbins as given to the first when starting a strand. The eccentric ring is of steel, and is connected with the cradles by a steel crank and brass bushing. The machine is also provided with a measurement wheel for keeping account of the output.

The Dunton Tree Insulator.

The Dunton tree insulator is an ingenious piece of apparatus recently manufactured and placed upon the market by



MALLEABLE IRON TREE INSULATOR.

Messrs. Dunton and Field, 117 Main street, Cambridge, Mass. As may be seen from the accompanying illustration this insulator is designed specifically to be used by keeping current-carrying wires from

making contact with the swinging limbs of trees. The insulator is so constructed that it can be used with any size of wire, and is made of the highest grade of malleable iron. The arm swings on a sleeve which is lag-screwed to the limb of a tree and turns in a cone-shaped casting pivoted to the lower end of the arm, which allows the glass insulator to be in a vertical position at all times when tied to the wire. A standard locust pin is driven in the cone-shaped casting and can not turn or come out when assembled to the arm. Special lag-screws are furnished with the insulators so that the body of the screw will enter the limb at least three-quarters of an inch, thus giving the full strength of the screw.

This insulator allows the wire to be tied solid to the glass without injury to the wire or to the tree. It allows the limb of the tree to which the insulator is attached to move in any direction. The apparatus is constructed so that any ordinary single, double and triple-petticoated insulator may be used.

An Important Circuit-Breaker Installation.

One of the most important circuit-breaker installations that has ever been made was recently completed when the

11,000-AMPERE MOTOR-OPERATED CIRCUIT-BREAKER.

New York Edison Company placed in operation nineteen 3,000-ampere, thirty-two 6,000-ampere and four 11,000-ampere General Electric circuit-breakers. All of the breakers in this installation are for operation on 250-volt service. The majority of them operate automatically for the protection of apparatus and lines against severe overloads and short-circuits. Some of them are designed for operation on reverse current. All of the breakers have been installed within the past year and are giving entire satisfaction.

The New York Edison Company has, after a thorough investigation, decided to adopt the standard General Electric Company design. The accompanying illustration shows one of the 11,000-ampere motor-operated breakers, which are the largest ever built.

Reclamation of the Yuma Desert.

One of the most difficult irrigation undertakings of the present day is the proposition to transform 85,000 acres of the arid Yuma desert into fertile farming land. The United States Reclamation Service has awarded the contract for this work to J. G. White & Company, Incorporated.

The project presents almost insurmountable difficulties in many ways. The nearest town is the city of Yuma located twelve miles down the Colorado river. Suitable drinking-water is extremely scarce, and the summer temperature in the Yuma desert ranges from 100 degrees to 120 degrees. A modern camp will be built, and will be controlled by special officers employed by the contractors, or by the government police of the Indian reservation. It will be equipped with a complete refrigerating system to provide ice and cold storage.

The transportation difficulties will be overcome to a great extent by the use of a thirty-foot gasoline launch to run as an express boat between the dam and the city of Yuma. Barges and other floating equipment will be used to transport heavy supplies. At the dam will be located complete telephone and telegraph systems so that constant communication may be had with the city of Yuma.

At a point where the Colorado river forms a dividing line between the state of California and the territory of Arizona, a dam one mile long will be built across the river. It will extend completely across the valley, and will have a sluiceway at either end which will be connected with the main arteries of the system of irrigating canals. Under ordinary conditions the Colorado river at this point is about one-quarter of a mile wide, but the flats on either side are frequently flooded by high-water. This is especially the case during the early summer months when heavy floods are caused by melting snow in the mountains.

The contractors estimate that the work will require the removal of over 300,000 cubic yards of solid rock excavation, and 300,000 cubic yards of lighter material. The rock will afterward be used for filling in the dam. The three vertical concrete core walls in the interior of the dam will require 30,000 cubic yards of concrete and 50,000 linear feet of sheet piling, and 80,000 cubic yards of rock paving, three feet thick, will be needed to complete the face of the dam.

Very little work can be done during the time of heavy floods, and the construction is to be pushed rapidly this fall and winter so that the dam may be finished before the wet season of 1906. To facilitate construction, large orders have already been placed for prompt shipments of the elaborate equipment necessary to successfully complete the work. Construction will be supervised by specially trained men who will act under instructions from their New York office. As indicative of their determination to finish this great work within the year, it is interesting to know that work was actually commenced by the White Company's engineers within six hours after the contract had been signed.

Hydroelectric Plant at Oldtown, Me.

The Milford Construction Company, Wallace C. Johnson, of Niagara Falls, chief engineer, has closed a contract with James B. Mullen, of Bangor, Me., for constructing its dam and power-house. The plant consists of a concrete dam about one thousand feet long across the Penobscot river at Oldtown, Me., giving about twenty-five feet head, and a power-house containing twelve 1,000-horse-power generators direct-connected to water-wheels.

Water power has been used at this point for several years. About 3,500 horse-power is now in use produced by a wing dam and canal along the west bank of the river. The power produced by the new plant will be transmitted to the city of Bangor, fifteen miles away, where a market for all that can be produced by this plant exists.

A Unique Souvenir.

At the Electrical Exhibition recently held in Boston, Mass., in connection with the National Electrical Contractors' Association, S. B. Condit Jr., & Company, New England agents for the Safety-Armorite Conduit Company, of Pittsburg, Pa., distributed an expensive and practicable souvenir in the shape of a desk clock. This was arranged in the form of a paper-weight and has been highly prized by all who were fortunate enough to secure one.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TO ELECTRIFY SYSTEM—A proposition to rebuild and electrify the street railway system of Guadalajara, Mexico, is under consideration. The expenditure involved will amount to about $3,000,000, including $400,000 demanded by the state for the concession and exclusive privilege to occupy the streets. Plans are to be submitted to the governor not later than September 15. The electric system will consist of twelve independent circuits, and the power will be derived from the falls of Juanacatlan. Eight years are allowed within which to complete the work.

FERROMANGANESE PLANT—Attorney-General Pugsley, of New Brunswick, has succeeded in interesting New York capital to the extent of $10,000,000 in large deposits of bog iron, or manganese, which were recently discovered near Grand Falls, N. B. A plant will be erected at the latter point to treat the ore by electricity, the intention being to manufacture ferromanganese on a large scale. The company will also generate electricity and sell it to towns along the St. Johns river. They will also purchase and contemplate electrifying the International Railway between Cambellton and Grand Falls. Pulp and paper mills with a capacity of 600 to 800 tons a day are also spoken of.

BIG POWER PLANT PLANNED—Contracts have been awarded by the United Electric Light and Power Company, Baltimore, Md., for the machinery for its new power station at Westport. This new plant will occupy a portion of the tract of twenty-three acres which the company bought last fall at the junction of the South Baltimore branch of the Baltimore & Ohio Railroad and the tidewater line of the Western Maryland Railroad. In addition to these two railroads the company has a water frontage for receiving coal in barges. The present outlay in its plant will amount to about $1,000,000, but the plans are arranged for duplicating the station now to be equipped. Bids for the erection of the building were opened on August 8, and contracts will be awarded as soon as possible. It is the expectation that the new plant will be ready to furnish power by January 1. An interesting feature of the new station will be that its machinery will have the same characteristics as the Pratt street power-house of the United Railways, so that power may be interchanged in case of emergency. The output of the Westport plant will be an alternating current of 13,000 voltage and a frequency of twenty-five cycles per second.

INDEPENDENT TELEPHONE COMPANY TRIES TO ENTER NEW YORK—A new company, the Atlantic Telephone Company, is announced to operate in all of the boroughs of Greater New York. The Atlantic Telephone Company was organized under the laws of the state of New York and has a present capital of $5,000,000. Its authorized capital is $25,000,000 and the directors of the company have also authorized the issuing of bonds to the amount of $15,000,000. All of the financial plans of the company are said to have been perfected. It is the intention of the company to install an independent telephone system in Greater New York and to connect this system with the other independent companies of the country. The application of a franchise for the new company has been heard by the Board of Estimate and Apportionment and there will probably be another hearing shortly. The company offers to pay the city for its franchise one per cent of its gross earnings for the first year, two per cent of gross the second year and four per cent of gross for the next twenty-two years thereafter, and also give to the city for its different departments 500 telephones free of charge. The directors of the company are J. D. Powers, Louisville, Ky.; Edward L. Barber, Wauseon, Ohio; Arthur A. Brownlee, of the United Copper Company; Frederick W. Brown, of the Stock Exchange firm of Seneca D. Brown & Company; Charles R. Dilworth, of the firm of Porter & Dilworth, Pittsburg; Louis T. Watson, of the Stock Exchange firm of Watson & Company, New York and Minneapolis; George Mitchell, of the Mitchell Mining Company; John M. Shaw, of the firm of J. B. Russell & Company, which built and own the independent telephone company at Chicago and which built and are now operating the Chicago subway; John A. L. Campbell and Arthur B. La Far, secretary and treasurer of the company.

POWER PLANT ON THE CATAWBA RIVER—The Southern Power Company is engaged in an undertaking at Great Falls, in Chester County, South Carolina, where it has three falls of seventy, fifty and forty-five feet. The company is now at work developing the seventy-foot fall and as soon as this work is completed it will begin on the other two. This work is now being carried on by practically the same force that built and put in service the power plant formerly known as the Catawba Power Company. With the developing of the three falls at Great Falls the capacity will be augmented by 60,000 horse-power. When the work at Great Falls is completed, the company will move on up the Catawba to Mountain Island, and there begin the development of that property, which will add about 20,000 horse-power to its supply. Great Falls, where the development is now under way, is located on the Wateree river, which in North Carolina is known as the Catawba. It is about eight miles from Lancaster; twelve miles from Winnsboro; fifteen or sixteen miles from Chester, and about ten miles from Heath's mill. It is the purpose of the Southern Power Company to distribute the power developed at Great Falls in the towns and cities in South Carolina, or at least as much as may be taken. Camden will want some, Columbia will take 10,000 horse-power. Then 10,000 horse-power will be brought to Charlotte, thereby increasing the actual amount of horse-power to 22,000 for Charlotte. It is also the intention of the company to distribute 10,000 horse-power in Gastonia and that immediate section. The officers of the Southern Power Company are as follows: W. Gill Wylie, president; B. N. Duke, first vice-president; W. S. Lee, second vice-president and engineer in charge; Richard B. Arrington, secretary and treasurer; W. H. Martin, assistant secretary and treasurer. The board of directors is composed of the following: J. B. Duke, B. N. Duke, W. G. Wylie, R. H. Wylie, W. S. Lee, Julius Christensen, Junius Parker and Frank L. Fuller.

LEHIGH VALLEY TRANSIT COMPANY—At a meeting held July 28, the properties and franchises of the Lehigh Valley Traction Company and its affiliated corporations bought at the several foreclosure sales were conveyed to the Lehigh Valley Passenger Railway Company, the Philadelphia & Lehigh Valley Passenger Railway Company and the Allentown & Slatington Passenger Railway Company, respectively. The boards of these several reorganized companies met for organization and the following directors and officers were elected: directors, Tom L. Johnson, Arthur E. Newbold, Harry C. Trexler, E. B. Smith, George O. Albright, William F. Harrity and George H. Frazier. The boards elected the following officers: president, Harry C. Trexler; vice-president, Edward M. Young; secretary and treasurer, George H. Frazier; general manager, Warren S. Hall, and auditor, C. M. Walter. This action is a step toward the merger of all the properties into one company —the Lehigh Valley Transit Company. The organization of this company will take place shortly. The company will spend nearly $2,000,000 in improving the system. This will include a new equipment of cars, a new power-house and car barn on top of the hill in South Allentown, the rebuilding of every foot of roadway and a general overhauling of the lines. Work on these improvements will be begun at once. The Lehigh Valley Traction Company has been in the hands of receivers for a little more than two years and for eighteen months the company has been in process of reorganization, the plan being prepared by a committee consisting of George H. Frazier, Edward B. Smith and W. F. Harrity, of Philadelphia, Colonel H. C. Trexler, of Allentown, and Mayor Tom L. Johnson, of Cleveland, Ohio. This committee completed its work on July 20, of last year. The new company will not only succeed the Lehigh Valley Traction Company, but will embrace in one big system the 260 or more miles of trolley lines, extending to the north as far as Egypt, Siegfried and Slatington, to the south as far as Philadelphia, to the east as far as Bangor and Nazareth, and to the west as far as Macungie.

ELECTRIC LIGHTING.

MARION, OHIO—The Prospect Electric Light Company is making preparations to install additional machinery at its power-house.

SAUSALITO, CAL.—The California Central Gas and Electric Company is now in possession of the Sausalito Electric Light Company's plant.

JEFFERSON, TEX.—Fire destroyed the plant of the Jefferson Ice, Light and Power Company's building on July 5. The loss is $16,000, covered by insurance.

ELKTON, MD.—The Elkton Electric Light Company has secured a contract from the board of town commissioners of North East to light that town with electricity for the next two years. The power will be furnished from the hydroelectric station at Gilpins Falls.

PHOENIX, B. C.—The West Kootenay Power and Light Company, Limited, is building a high-tension power line from its hydroelectric plant at Bonnington Falls some eighty-three miles into the Boundary country, to supply mines and smelters with the power.

ALLENTOWN, PA.—The Bangor Electric Light, Heat and Power Company, of Bangor, has given a mortgage for $75,000 to the Northampton Trust Company, of Easton. The mortgage covers an increase of capital stock approved by the stockholders in April last.

DES MOINES, IOWA—The Peterson Heating and Lighting Company, of Des Moines, has secured the controlling interest in the Iowa Falls lighting plant by the purchase of $40,000 worth of stock. This company now controls a number of lighting plants in Iowa.

LAKE CHARLES, LA.—At the election to determine whether or not the city of Lake Charles should issue $75,000 worth of bonds for the purpose of building and maintaining a municipal electric light plant, the proposition was voted down by a majority of over six to one.

MUNCIE, IND.—The Muncie Electric Light Company has announced a cut in its rate from twelve and one-half to ten cents per kilowatt-hour. In addition, the company proposes to make a rate of six cents per kilowatt-hour for the excess above 24,000 kilowatt-hours used by one consumer.

SALEM, MASS.—The Salem Electric Lighting Company has contracted for a 350-horse-power boiler of the Babcock & Wilcox water-tube type. The boiler will be installed and ready for use in three months. There are at present eight 125-horse-power boilers at the stations of the return tubular type.

YORK, NEB.—The York Electric Light and Power Company and the York Gas Company have effected a consolidation and will be known as the York Electric Light, Gas and Power Company. C. A. Haas, of Omaha, has been elected president, and J. A. Peffer, manager. The capital stock will be about $100,000.

BOSTON, MASS.—The gas commissioners have authorized the Natick Gas Company and the Webster Electric Company to issue 250 and 150 additional shares of stock, respectively, both at $100 a share. The new stock in both cases is for additions to the plants, and will be offered to stockholders pro rata.

SHREVEPORT, LA.—The Shreveport Gas, Electric Light and Power Company has placed on record a mortgage in favor of the American Trust and Savings Bank, of Chicago, for $1,000,000. The bonds to be issued under this mortgage will be used to retire outstanding bonds and to make improvements in the property.

ANN ARBOR, MICH.—The Washtenaw Light and Power Company will light the streets of Ann Arbor for five years, a contract having been let to it at $63 per light for 150 lamps, the lights to burn every night from dusk to dawn. These figures mean $9,450 per year, or a total of $47,250 for the time of the contract.

CUMBERLAND, MD.—A report has been made in regard to the electric plant for the past year. Two hundred and fifty-three arc and twenty incandescent lamps were in use and 1,270 tons of coal were consumed. The lights burned 4,037 hours during the year. The total expenditures for the year amounted to $7,879.01. The hourly cost of each lamp was 0.0084 cent.

WORCESTER, MASS.—The annual meeting of the stockholders of the Southbridge Gas and Electric Light Company was held recently. The following directors were reelected: Henry C. Cady, Calvin D. Page, Henry C. Wells, John M. Cochran, John A Hall, George N. Corey and Andrew F. Hall. The following officers were chosen: clerk, Albert D. Wells; treasurer, George N. Corey; auditors, John M. Cochran and Fred E. Coburn.

SALT LAKE CITY, UTAH—The Utah Light and Railway Company, through its local manager, W. Wade, has announced a reduction in the meter price for electric lighting within Ogden City, the reduction to be in force until further notice. Heretofore the rate has been fifteen cents per kilowatt-hour. The new rate is eleven cents, with the usual ten per cent reduction when bills are paid on or before the seventh of the month.

PALOUSE, WASH.—D. G. Klinefelter, proprietor of the Palouse Electric Light and Power Company, has closed a contract with M. J. Shields, of the Moscow Electric Light and Power Company, whereby Mr. Shields will furnish the local plant with 275 horsepower. The wires will be strung and the current turned on November 1 next. The contract calls for 275 horse-power, with the privilege to any amount necessary to handle the business.

PLAINWELL, MICH.—The Eesley Light and Power Company has secured possession of the Brownell Electric Company's plant and by the addition of a new large power plant, now completed, will furnish power and lighting for business places and private dwellings, as well as for the village. The new company is capitalized at $30,000, and its officers are: president, J. E. Eesley; vice-president, James Smith; secretary, Caroline Scott; treasurer, F. J. Scott.

BIRMINGHAM, ALA.—The reduction in the price of electricity furnished consumers by the Birmingham Railway, Light and Power Company has gone into effect according to an agreement made with the city some time ago by the Birmingham Railway, Light and Power Company. Current is now furnished consumers at the rate of twelve cents per kilowatt-hour with a discount of ten per cent if bills are paid in ten days. The price at present paid for electricity is sixteen cents per kilowatt-hour.

WOONSOCKET, R. I.—The Woonsocket Electric Machine and Power Company is about to install in addition to the new power station, on Front street, two new steam turbines for the purpose of supplying power to the new Providence & Burrillville Street Railway Company. This power is to be supplied by the company in accordance with contracts recently entered into between the electric light company and the Woonsocket Street Railway Company, the Columbian Street Railway Company and the Providence & Burrillville Street Railway Company.

OMAHA, NEB.—The Omaha Electric Light and Power Company has sold to N. W. Harris & Company an issue of $1,200,000 first mortgage five per cent gold bonds. The company controls the electric light and power business in Omaha and South Omaha, with the exception of a small amount of power in Omaha, and by ownership of stock controls the entire gas, electric light and power business in Council Bluffs, serving a total population of about 170,000. The company has been paying dividends of five per cent on its preferred stock since August, 1903.

ST. JOHNSBURY, VT.—A deal has been consummated by which the St. Johnsbury Electric Company has acquired of E. T. and H. K. Ide, of St. Johnsbury, the water power at Passumpsic. This amounts to about 400 horse-power and the electric company will erect at once a modern station to supply more power and lights for St. Johnsbury. When completed this will make the third station the company owns on the Passumpsic river and hereafter it expects to run its plants by water power, using the steam plant at the central station only in an emergency.

DENVER, COL.—Fort Collins light consumers are assured of a fifty per cent reduction in lighting charges by the terms of a contract entered into by the board of aldermen and a syndicate headed by George H. Sethman. The contract leases to the syndicate the old Fort Collins waterworks and pumping plant for a term of six years, the city to receive an annual rental of $1,200. The company will generate electrical power and supply electric light. At the end of six years the city may take over the entire plant by purchase on terms favorable to the municipality.

TELEPHONE AND TELEGRAPH.

RICHMOND, VA.—The Petersburg Telephone Company will erect a new exchange building.

NEWARK, N. J.—The New York & New Jersey Telephone Company has erected a line through Oak Ridge.

WILMINGTON, DEL.—The Delaware & Atlantic Telephone Company will install an exchange at New Castle.

SAN BERNARDINO, CAL.—The San Bernardino board of supervisors has granted a fifty-year telephone franchise to Nathan W. Tarr.

JACKSONVILLE, FLA.—The Alachua Telephone Company has completed a line to Gainesville, and is now erecting one to La Crosse.

GOSHEN, IND.—The Elkhart Home Telephone Company will install a new switchboard with an ultimate capacity of 2,000 instruments.

CRIPPLE CREEK, COL.—The Colorado Telephone Company has announced that it will erect a two-story brick building to cost $10,000.

BANGOR, ME.—The Eagle Lake Telephone Company has completed its line from Fort Kent to Eagle Lake Mills, Portage Lake and Smyrna Mills.

DETROIT, MICH.—The Michigan State Telephone Company will build a new trunk line over the Michigan Central right of way from Detroit to the upper peninsula.

UTICA, N. Y.—The Central New York Telephone and Telegraph Company is building a new long-distance line between Utica and Syracuse, capable of carrying thirty wires.

CHESTER, PA.—The borough council has adopted an ordinance granting the Delaware & Atlantic Telephone Company the right to lay underground conduits in the borough.

BIRMINGHAM, ALA.—The Southern Bell Telephone and Telegraph Company announces that it will shortly begin work on a four-story pressed brick building which will cost $50,000.

KOSSUTH, MISS.—J. W. Doggett and J. R. Hill are putting in a private telephone line which is to connect with the Cumberland at Corinth. It is possible that a local exchange may be installed.

MOUNT STERLING, OHIO—A majority of the stock in the Mount Sterling Telephone Company has been purchased by Henry Hildebrandt, his son and some other gentlemen whose names are not given.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company has decided to enlarge both the Madison and Gilmor exchanges. A floor will be added to the former and an addition erected for the latter.

LYNCHBURG, VA.—The telephone line between Bedford City and Big Island, which has been in course of construction for some time, has been completed and the lines opened for business. A number of intermediate stations are on the line.

ALTOONA, PA.—The United Telephone and Telegraph Company has completed the work of installing a private system of telephones for the use of the Altoona & Logan Valley Street Railway Company. These telephones are located at the power-house, offices, car barns and along the lines.

EUGENE, ORE.—Another rural telephone company has been organized by the farmers between Creswell and Camas Swale, and a line will at once be constructed between these points a distance of eight miles. The officers of the company are: Marion Hager, president; Henry Parsons, secretary; Ernest Schwering, J. Wulsleger and Lucas Cowgill, directors.

SPRINGVILLE, N. Y.—The Springville Telephone Company has signed a contract with the Inter-Ocean Telephone and Telegraph Company for long-distance telephone connections. The Inter-Ocean's lines will connect the company directly with the Frontier Telephone Company, of Buffalo, and with over seventy-five thousand independent subscribers in western New York.

DETROIT, MICH.—The Michigan State Telephone Company, which succeeded the Michigan Telephone Company, issues its statement for the fiscal year to April 30, 1905. Gross earnings were $2,089,702, net $596,045, and the surplus above charges and six per cent dividends on the preferred was $224,061, which was used for betterments. The maintenance expenses for the year were $579,955. Since the present management took possession, in February, 1904, the outstanding telephones have increased from 48,788 to 70,832.

KAUKAUNA, WIS.—The Wisconsin Telephone is building two new toll lines from Kaukauna to Manitowoc. The only way of reaching Manitowoc in the past has been *via* Milwaukee and Sheboygan. One line will be used exclusively for Manitowoc, while the other will enter stations at Dundas, Brillion, Forest Junction, Grimms, Reedsville, Cato, Whitelaw and Branch.

EVANSTON, WYO.—The Rocky Mountain Bell Telephone Company has announced that work will soon be commenced on the construction of a line from Evanston to Montpelier, Ida. This will establish direct communication between Evanston and Grover, Fairview, Smooth, Ashton, Bedford, Thayne, Afton, Freedom, Carter, Kemmerer, Diamondville, Cokeville and Montpelier.

DUNDEE, N. Y.—At the annual meeting of the directors of the Crosby & Barrington Telephone Company officers and directors were elected as follows for the ensuing year: president, Charles E. Guile; vice-president, Howard S. Fullager; secretary and treasurer, Herbert C. Ovenshire; directors, Isaac Crosby, T. W. Windnagle, James K. Thayer, Howard Fullager, Herbert C. Ovenshire and Charles E. Guile.

ENSLEY, ALA.—The Southern Bell Telephone Company will shortly begin the work of enlarging the Ensley office and improving the service. It is understood that a new switchboard, with capacity double the present one, will be installed. This year the company has done a large amount of work replacing the old poles by taller ones, and stretching additional wires between Ensley and Birmingham.

PHILADELPHIA, PA.—The directors of the Keystone Telephone Company have increased the membership of the board from five to eleven members, ten of whom were elected. This completes the reorganization of the company which has been in progress. The following is a list of the members of the present board: F. Wayland Ayer; Marcus Beebe, of Boston; George Burnham, Jr.; N. T. Folwell; Clarence L. Harper; James Collins Jones; George Kessler; Heulings Lippincott, Camden, N. J.; Michael Murphy, Philadelphia; Jacob E. Ridgeway. The new board organized by electing N. T. Folwell, president; James Collins Jones, vice-president; W. W. Wharton, secretary and treasurer, and C. E. Wilson, general manager.

HARRISBURG, PA.—The United Telephone and Telegraph Company, of Philadelphia, has sold to H. P. Taylor & Company, of Pittsburg, $500,000 first mortgage five per cent thirty-year gold bonds, of which $250,000 are bonds of that company and $250,000 bonds of the Cumberland Valley Telephone Company, principal and interest guaranteed by the United Telephone and Telegraph Company. The price paid for these bonds is said to have been at a considerable advance over the prices at which these securities previously sold. It is the intention of the United Telephone and Telegraph Company to greatly increase the long-distance service between Pittsburg and Philadelphia. It is estimated that by increasing its long-distance facilities the net receipts of the company can be increased not less than fifty per cent.

TROY, N. Y.—The annual meeting of the Commercial Union Telephone Company was held recently, and the following directors were reelected: John T. Christie, W. Levis Burk, William Connors, Cornelius V. Collins, Stephen C. Medbery, Charles W. Cool, Edward Davis, James H. Caldwell, Peter McCarthy, William C. Geer, William D. Mahoney, Edgar T. Brackett, Brodie G. Higley, William D. Barnard and Arthur Mac Arthur. Subsequently the directors reelected the following officers: president, John T. Christie; vice-president, James Caldwell; secretary, W. Levis Burk; treasurer, Peter McCarthy; assistant treasurer, William C. Colburn. A financial statement was presented, showing that the gross earnings for the year amounted to $148,140.75. The expenses were $64,995.08, making the net earnings $83,145.67. To the surplus account $28,100.83 is credited. A dividend of six per cent has been paid on the preferred stock this year in two instalments, paid January 1 and July 15. The company reports 5,632 telephones in service, which is an increase of 1,239 for the year. Owing to the increased demands for the service it has been necessary during the year to increase the switchboard capacity of all the exchanges, and at the present time additional cable facilities are being provided, which will increase the capacity of the system one-third.

NEW INCORPORATIONS.

DES MOINES, IOWA—Richland Telephone Company. Increased to $20,000.

SPRINGFIELD, ILL.—Olney Electric Light and Power Company. Increased from $20,000 to $50,000.

CLARKSVILLE, TENN.—The Consumers' Electric Light and Power Company. $10,000. Incorporators: R. W. Courts, W. M. Deane, A. F. Tilley, I. P. Gerhart and W. A. Chambers.

RICHMOND, VA.—Appleridge Telephone Association, Limited, Winchester, Va. $2,500. Incorporators: W. C. Graichen, president; R. T. Barton, secretary and treasurer, both of Winchester, Va.

RICHMOND, VA.—Bedford Power Company. $25,000. Incorporators: E. L. Moir, president, Roanoke, Va.; W. B. Trout, vice-president, Staunton, Va.; Waller R. Staples, secretary, Roanoke, Va.

BUFFALO, N. Y.—The Stratford Railway Construction Company. $50,000. Directors: Louis B. Grant, Ashley T. Cole, William J. Bagnell, Charles T. Lark and Alexander Keogh, all of New York.

COLUMBUS, OHIO—Toledo, Defiance & Southern Railway Company, of Defiance. To build a line through Hamilton, Butler Preble, Darke, Mercer, Van Wert, Paulding, Defiance, Henry, Fulton and Lucas counties. $10,000.

INDIANAPOLIS, IND.—Rosedale & Fontanet Farmers' Telephone Company, of Parke and Vigo counties. $3,000. Directors: Thomas M. Patterson, William Stuthard, George Rukes, Henry Stuthard and Charles Mulvahill.

CLARKSBURG, W. VA.—Weston Fuel and Light Company, of Weston. To produce and deal in oil, natural gas and electricity. $50,000. Incorporators: R. N. Koblegard, John Koblegard and John L. Ruhl, of Clarksburg, and B. A. Koblegard and T. F. Koblegard, of Weston.

NEW MANUFACTURING COMPANIES.

NEW HAVEN, CT.—The Burn-Peterit Manufacturing Company, with a capital of $400,000, will make gas and electric lighting fixtures.

CLEVELAND, OHIO—The Eureka Electric Lamp Company has been incorporated with a capital of $10,000 by G. B. Harris, Joseph J. Klein, E. M. Close, W. M. Rothschild and Fred Desberg.

DALLAS, TEX.—The Bryant Brothers' Company has been incorporated with a capital of $5,000, to buy and sell electrical apparatus, by R. C. Bryant, W. T. Davidson, W. H. Haggard and C. W. Robinson.

OAKLAND, CAL.—The Pacific Central Electric Company has been formed by W. W. Foote, E. M. Smith, Clarence M. Reid and Charles F. Reuter.

JERSEY CITY, N. J.—The United States Pay Station Company, with a capital stock of $50,000, has been incorporated to manufacture and deal in telephone equipment. The incorporators are H. O. Coughlan, Thomas F. Barrett and J. W. Woods.

CINCINNATI, OHIO—The Barriett Electrical Manufacturing Company has purchased the property of the Barriett Electric Company, and will begin operations in a short time. The capital is $25,000, and the incorporators are Mrs. L. K. Behrens, C. H. Haddrell, Edwin Shideler, E. N. Laralde and Henry Bently.

NEWARK, N. J.—The American Smoke and Fume Condensing Company, 160 Market street, will manufacture a certain machine, known as the Mockridge condenser, and electric motors and other machinery. The capital is stated as $1,000,000, and the incorporators are Edward E. Milke, 90 Lembeck street; Edward E. Milke, Jr., 129 Garfield avenue; Albert W. Mockridge, 163 Clinton avenue, all of Jersey City, N. J.

PORTLAND, ORE.—The Portland Car Annunciator Company has been incorporated with a capital of $100,000. The objects announced are to operate, equip and maintain an annunciator system, announcing any and all cars at certain points on any and all street car lines in the city of Portland, and within a radius of fifty miles of said city, under two certain patents known as the electric railroad signals, which patents were issued to Henry A. Amman and Albert D. Campbell in August, 1903, etc.

ELECTRIC RAILWAYS.

GRIDLEY, CAL.—Work on the Oroville & Chico Electric Railroad has been begun.

TOLEDO, OHIO—The Toledo Railways and Light Company has purchased for $60,000 the Toledo & Point Place line, a short trolley road.

LOS ANGELES, CAL.—Henry E. Huntington has closed deals involving $2,500,000. His latest purchases include the Redondo Electric Railway and about 4,000 lots in that resort.

PHILADELPHIA, PA.—The borough council has granted to the Philadelphia & Garrettsford Street Railway Company permission to construct and operate a trolley line in Clifton Heights.

WAYNESBORO, PA.—A trolley line from Chambersburg to Greencastle, to connect with the Chambersburg, Greencastle & Waynesboro road, is to be built. The line will be about ten and one-half miles in length.

MARSHALL, MICH.—The Jackson & Battle Creek Traction Company intends building a spur of its road to Duck lake next summer. It will start from Albion, and the old Toledo & Northwestern roadbed will be used.

BLOOMSBURG, PA.—At a meeting of the Bloomsburg council the ordinance granting the Bloomsburg & Millville Trolley Company a franchise was declared void. The company did not begin operations within the time specified in the ordinance.

SPRINGFIELD, MASS.—Work will be begun as soon as possible on the Bircham Bend extension of the Springfield Street Railway Company between Chicopee Falls and Indian Orchard, and it is expected that the line will be in running order by winter.

COHOCTON, N. Y.—It is believed that work will shortly be commenced on the electric railroad between Atlanta and Naples, for which a survey has lately been completed. New York capitalists, who are represented by George H. Switzer, are behind the project.

COLUMBUS, OHIO—Three deeds have been filed with the county recorder providing for the transfer of the Columbus, Delaware & Marion Electric Railroad Company to the Columbus, Delaware & Marion Railway Company, a reorganized corporation with a capital stock of $2,500,000.

EDWARDSVILLE, ILL.—The St. Louis & Northeastern Railway Company, through its president W. B. McKinley, has filed in the recorder's office a certificate of increase in capital from $400,000 to $1,000,000. The Northeastern is the corporate name of the McKinley line from Edwardsville south to East St. Louis.

JACKSON, TENN.—Negotiations have been closed between the Jackson & Suburban Car Company and a New York syndicate for the placing of $2,000,000 of bonds for an extension of the street car system through and around the city of Jackson and to Bemis, and for the erection of a complete new electric light plant.

LOUISVILLE, KY.—The survey of the projected electric railway from Lebanon to a point near Creelsboro, on the Cumberland river, has been completed. The grade is said to be good and the indications are that the road will be built. The route runs through the largest area in Kentucky not penetrated by a railroad.

PHILADELPHIA, PA.—By a vote of the stockholders the Philadelphia & Garrettsford Street Railway Company decided to increase its indebtedness by issuing bonds to the extent of $3,000,000. They will take the form of fifty-year five per cent general mortgage bonds, redeemable at 105 before maturity. They will be issued as the necessities of the company require.

SHELBYVILLE, IND.—J. W. Moore, of Anderson, in charge of a surveying corps for the Indianapolis & Cincinnati Traction Company, has begun a survey for the extension from Shelbyville to Greensburg. Two routes will be surveyed, one paralleling the Big Four, the other following the line of the old Michigan road. Work will begin immediately after the right of way is secured.

TOPEKA, KAN.—The Topeka, Eskridge & Council Grove Interurban Railroad Company has been chartered under the laws of Kansas to build an electric line from Topeka to Council Grove, 58.6 miles. The road will be built in Shawnee, Wabaunsee and Morris counties. Connections will be made at Council Grove with

the Missouri Pacific System for all points west on the Colorado & Salt Lake line, now building to the Pacific coast, and with the Missouri, Kansas & Texas for Oklahoma, Indian Territory and Gulf points.

BILOXI, MISS.—The Biloxi Electric Railway and Power Company, with all its holdings, has been sold to Captain Joseph T. Jones, of Gulfport, president of the Gulf & Ship-Island Railroad, for $200,000. Captain Jones, his son, Bert Jones, and Judge J. H. Neville acted for the purchasers and J. I. Ford, of Pascagoula, and W. A. White, of Biloxi, represented the stockholders.

COUNCIL BLUFFS, IOWA—The promoters of the proposed electric line from Council Bluffs to Griswold have organized temporarily with H. H. Van Brunt as president. Those associated with him are Congressman Walter I. Smith, H. A. Quinn, C. W. McDonald, H. W. Binder, E. H. Merriam and F. R. Davis. The company will be reorganized and the capital stock fixed after the survey is completed.

GLENS FALLS, N. Y.—The annual meeting of the Hudson Valley Railway was held recently and directors were elected as follows: A. B. Colvin, Glens Falls; John W. Herbert, New York; George A. Helme, New York; Peter McCarthy, Troy; Thos. Breslin, Waterford; James O'Neil, Troy; Frank E. Howe, Troy; William G. Bumsted, Jersey City; William L. Kiley, Glens Falls; Otto Bannard, New York; Douglas Robinson, New York; William B. King, New York; Dr. John P. Munn, New York.

PERSONAL MENTION.

MR. HINSDILL PARSONS, fourth vice-president of the General Electric Company, has resigned as president and director of the Schenectady Railway Company.

MR. A. D. SKINNER, manager of sales of the Skinner Engine Company, Erie, Pa., was a visitor to Chicago last week. Mr. Skinner reports a good present business and a bright outlook for the future.

MR. C. L. CHRISTLIFF has been appointed by the Baltimore (Md.) city engineers' department to prepare a map and gather detailed information concerning the subway and all other connections under the surface of the city.

MR. EDWARD P. COLEMAN, who has been connected with the Consolidated Lighting Company as manager and superintendent for six years, has been chosen manager and secretary-treasurer of the Wetmore & Morse Granite Company, Waterbury, Ct.

MR. F. E. FITZPATRICK, who has been manager of the California Gas and Electric Corporation in the San Rafael district for nearly three years, has been appointed manager of the Sacramento Gas, Electric and Railway Company, with headquarters in Sacramento city.

MR. E. E. LARRABEE, superintendent and manager of the Bennington (Vt.) Electric Light Company since its organization, has taken the same position with the Hoosick Falls (N. Y.) Illuminating Company, and will assume his duties at once. In his new position as assistant will be his son Harold, a graduate of the Massachusetts Institute of Technology, class of 1903, who has passed one year in Porto Rico, having just returned.

MR. JOHN H. JANEWAY, JR., has resigned his position in the engineering department of the John A. Roebling's Sons Company, Trenton, N. J., to become general manager of the Mineral Point Zinc Company, of Chicago, Ill. Mr. Janeway is a graduate of the Columbia School of Mines, and for fourteen years he has been next to President Charles G. Roebling in the engineering department.

MR. L. G. MOORE, who since 1902 has been the manager of the Southern Bell Telephone Company in Jacksonville, Fla., has sent in his resignation to the company, is succeeded by Mr. C. L. Bragg, of Tampa, who has been the telephone manager in that city for the past two years, and who has been with the telephone company for many years. Mr. Moore, who has been a most efficient manager, resigns to go into the real estate business. When Mr. Moore took charge of the Jacksonville telephone business in 1902 there were only 830 telephones, and he has raised that up to 2,300 telephones and increased the number of girl operators from nine to twenty-five.

MR. CHARLES R. HUNTLEY, general manager of the Buffalo General Electric Company, accompanied by his family, is making an extensive western trip. Mr. Huntley is a member of the executive committee of the New York state commission to the Lewis and Clark exposition at Portland, Ore., and it is principally for the purpose of attending the exposition that Mr. Huntley decided upon making this trip. He will visit the Yellowstone National Park, San Francisco, and other places of interest in the West, and expects to be gone about one month in all.

ELECTRICAL SECURITIES.

While dealings in the stock market have been of decidedly limited proportions, there has been evident a domination of strong hands and determination to hold prices at the present level. The crop outlook, the monetary situation, and the prospect of peace between Russia and Japan are dominant factors in the present trend of affairs. Recent statistics of record bank clearings and railroad earnings are a welcome reflection of the general condition of industry.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 5.

New York:	*Closing.*
Brooklyn Rapid Transit	69½
Consolidated Gas	192½
General Electric	178
Interborough Rapid Transit	207½
Kings County Electric	200
Manhattan Elevated	166¼
Metropolitan Street Railway	127⅝
New York & New Jersey Telephone	168
Westinghouse Manufacturing Company	168

Brooklyn Rapid Transit, General Electric, Metropolitan, New York & New Jersey Telephone and Westinghouse declined very slightly, while Consolidated Gas and Manhattan Elevated made advances. The gross earnings of the Brooklyn Rapid Transit for July exceed, it is said, $1,600,000. It was rumored last week that the Metropolitan Street Railway had acquired control of the Coney Island & Brooklyn Railroad.

The Consolidated Gas Company has declared a quarterly dividend of 2 per cent, payable September 15. Books close August 25 and reopen September 16.

Boston:	*Closing.*
American Telephone and Telegraph	138½
Edison Electric Illuminating	245
Massachusetts Electric	60
New England Telephone	135
Western Telephone and Telegraph preferred	98

The June instrument statement of American Telephone showed a gross and a net output of 120,555, and 68,128 instruments, respectively. This does not compare very favorably with other months, but it must be remembered that this is a dull season, and it is announced that the company is growing with consistent rapidity.

Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	83
Electric Storage Battery preferred	83
Philadelphia Electric	8⅞
Philadelphia Rapid Transit	28⅝
United Gas Improvement	99¾

The Philadelphia market maintained a quiet, steady tone all week. Electric Company of America, Philadelphia Rapid Transit and United Gas Improvement made substantial gains, the latter 4 points.

Chicago:	*Closing.*
Chicago Telephone	135
Chicago Edison Light	155
Metropolitan Elevated preferred	64¾
National Carbon common	60
National Carbon preferred	116
Union Traction common	30
Union Traction preferred	37

INDUSTRIAL ITEMS.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., in bulletin No. 55 describes and illustrates small generators arranged for direct connection.

THE GEORGE WORTHINGTON COMPANY, Cleveland, Ohio, has ready for distribution its new electrical catalogue. This comprises 184 pages, including a very complete index. Everything of an electrical nature appears to be included in the apparatus listed.

STANLEY & PATTERSON, INCORPORATED, 40 Cortlandt street, New York city, is calling attention to the cores of its "Faraday" skeleton bells in a new mailing card. Full information concerning these bells will be furnished by the company upon request.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., has published an attractive little booklet entitled "Electric Light Jingles." This contains a number of verses demonstrative of the advantages of electric light in business and domestic illuminating.

ALFRED F. MOORE, 200-218 North Third street, Philadelphia, Pa., is distributing an attractive series of calendar cards calling attention to the apparatus which this company handles. The company makes a specialty of switchboard cords, receiver cords, insulated wires and cables.

THE CENTURY ELECTRIC COMPANY, 404 North Fourth street, St. Louis, Mo., in bulletin No. 5 describes and illustrates "Single-Phase Alternating-Current Motors." These motors are self-starting under full load. The company is also calling attention to the "Pillsbury" alternating-current ceiling fan.

THE HOLYOKE MACHINE COMPANY, Worcester, Mass., is illustrating and describing its improved governor for water-wheels in a new booklet. Correspondence is invited regarding the mechanical features of this apparatus. Specifications, with prices and other particulars, will be submitted upon request.

THE UNITED STATES CARBON COMPANY, Cleveland, Ohio, is being overhauled and the plant furnished with new apparatus for the manufacture of carbon product. Mr. Burton P. Foster is the manager of the company, and it is said that the Rockefeller oil interests will supply the necessary financial backing.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., will send a copy of August "Graphite" free upon request. This issue contains a number of interesting articles dealing with the manufacture and sale of graphite products. There is also an article entitled "Something about Condensers," by W. H. Wakeman.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., is distributing a bulletin descriptive of standard porcelain specialties. This illustrates and describes a complete line of porcelain insulators, cleats and tubes. The book will be found to be a handy reference on porcelain goods. The company will mail a copy on request.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., in circular No. 1062 describes type F induction motors for variable speed. In addition to the diagrams and dimension plates there are illustrations of the assembly of this machine, together with a number of typical performance curves showing the characteristics of the apparatus.

THE WHEEL-TRUING BRAKE SHOE COMPANY, Detroit, Mich., is mailing an attractive folder, entitled "In the Good Old Summer Time." This calls attention to the increased earnings of the railway man during the summer, but also suggests that he can not afford to run his cars unless the wheels are in good shape, this condition being brought out, of course, by the application of wheel-truing brake shoes.

THE AITON MACHINE COMPANY, 126 Liberty street, New York city, has issued bulletin No. 79, illustrating one of its horizontal types of cabling or closing machines for laying up large cable. Specifications and quotations will be furnished upon application at the New York office of the company. Bulletin No. 92, describing three-reel vertical stranding machines for manufacturing power cables, is also ready. The gears on these machines throughout are cut, and all parts of the machine are carefully tooled. The bearings are amply proportioned and provided with ample oiling facilities. The alignment of the machine is preserved by roller bearings which can be adjusted from time to time without trouble.

THE AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., has published a handsome booklet descriptive of the improved Holly system of direct and exhaust steam heating for cities and villages through underground mains. The booklet illustrates the North Tonawanda plant and the Lockport plant. The plan and operation of the system is carefully detailed and special illustrations are given, showing the scheme of distribution. The company now has 250 plants in operation.

THE BALL ENGINE COMPANY, Erie, Pa., has prepared a small booklet descriptive of new designs of Ball engines. The apparatus represented includes a side crank, single-cylinder engine, both belted and direct-connected; a tandem-compound, side crank engine, direct-connected; a cross-compound, side crank engine, direct-connected; a horizontal, single-cylinder Corliss engine with improved valve motion; a horizontal and a vertical cross-compound Corliss engine with improved valve motion.

THE AMERICAN CONDUIT MANUFACTURING COMPANY, Pittsburg, Pa., has completed the main building of its new factory and now has this department in full operation. The building is equipped with the latest facilities for making electric wire conduit, and its present operation has demonstrated that the plant is capable of doubling the output and at the same time improving the quality of the goods. The company has also secured better railroad facilities, enabling quick delivery on any quantity of material.

THE D. T. WILLIAMS VALVE COMPANY, Cincinnati, Ohio, has made arrangements for the exclusive manufacture and sale of the Cookson steam trap and separator, formerly manufactured by the Cookson Steam Specialty Company, Cincinnati, Ohio. The Williams company states that it has purchased the patterns, patents and good will of Thomas J. Cookson and the exclusive rights to manufacture his trap and steam specialties. This trap is well known throughout the country, and is handled by a large number of jobbers.

THE CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., has recently secured contracts for its enclosed, self-oiling, direct-connected engines in the following institutions: Purdue University, Lafayette, Ind.; main power plant, Indiana State Normal School, Terre Haute, Ind.; Girls' Industrial School, Indianapolis, Ind.; two units for the Michigan College of Mines, Houghton, Mich. These engines are built in accordance with the recommendations of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, for direct-connected units.

LEGAL NOTE.

TELEPHONE COMPANY CAN NOT INCREASE ITS RATES—An interesting decision has been handed down by Judge Harlan in the Circuit Court at Baltimore, Md. The Home Telephone and Telegraph Company, an independent organization, made a proposition in 1896 to the city council of Baltimore that if it received a franchise to do business in Baltimore it would furnish service to business subscribers for $48 a year, and to residence subscribers for $36. The city council accepted the proposal and adopted an ordinance embodying the rate schedule proposed, which was, in turn, accepted by the company. Later the name of the company was changed to the Maryland Telephone and Telegraph Company. After furnishing service for six years at these rates the company found that it could not pay its charges unless it increased its rates to the level maintained by the Bell Telephone Company. An attempt was therefore made to secure a repeal of the rate ordinance, but due to opposition developing in the city council, the plan was abandoned. The company then decided to raise its rates, and public notice was served that the rates would be increased to $72 for business and to $60 for residence subscribers. Suits were brought by subscribers to enforce the rates named in the ordinance. For about two years the case has been in the courts. Judge Harlan's decision is that the company must furnish service at the rates provided for in the ordinance.